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Engineering News-Record

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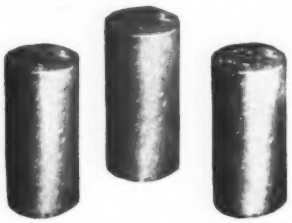

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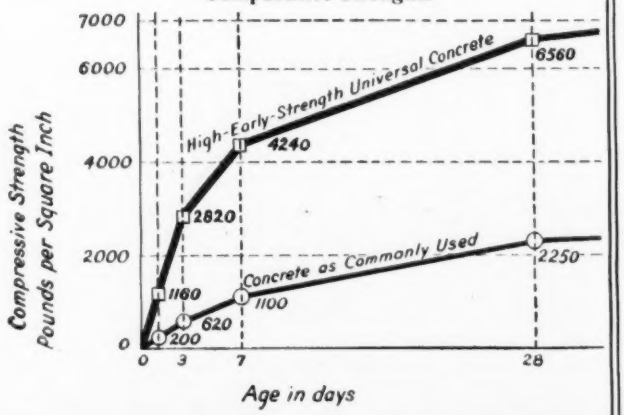

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Volume 102 NEW YORK, MAY 23, 1929 Number 21

Everyday Safety

FEELINGS of helplessness before the threat of unforeseen chance are the first impressions of the horrible tragedy that befell the Cleveland Clinic last week. Here was an institution devoted to saving life, and planned to that end with much skill and knowledge: in a few moments it became the tomb of a helpless hundred, victims of a sudden cloud of poisonous gases. Can this be anything other than maleficent fate, more powerful than human forethought? It seems as though the long struggle against the black powers of accident were futile, and that all of our long labors for human safety were wasted effort. But then one hears of a great store of dangerous X-ray film in the heart of the building, of steam pipes nearby, of fire doors that would not close, of failure in many ways to fend off evil chance; and the appalling fire generation of poison gas appears more credible, indeed almost inevitable. There was a potential powder magazine in the midst of the institution, in short, and it was left unguarded. We have long known that safety which is built into a structure endures only so long as it is maintained day by day, but to our sorrow we must learn it again. Perhaps we need to learn it again and more lastingly, in this time of great massing of men and matter, in this age of complex chemical substances. Those dangers which we ourselves create we should surely study and guard; and we must remember to guard them every day.

Even the Government

THERE are simpler dangers than those of film storage which may bring equally serious consequences. For example, there is the inward-opening exit door. At Washington one may see a group of government buildings where hundreds of people are at work: the doors of many of these buildings open inward. Long years ago it was learned that inward-opening doors are a grave menace in public buildings. Let the slightest mishap bring a rush to escape, and panic will pile masses of crushed victims against the doors held shut by their pressure outward. Disaster after disaster has burned this truth upon the record book of safety practices, yet some continue to ignore it—even the government of the United States! "Why do these doors open inward?" we asked a worker there. He answered that the government's architect who designed the buildings had a leaning toward inward-opening doors, and that the officials directing the bureau housed in the buildings have no authority to change the doors. Possibly he was in error and the blame belongs elsewhere, for in the complicated structure of federal departments and bureaus it is not always easy even for the initiate to locate final responsibility. Yet the bald fact remains that in this center of intelligent effort, this national government which the citizens of the country look upon with pride and veneration, there is found the same lack of forethought for which the private citizen, the speculative builder or owner, the meretricious architect, has often been condemned. The government is under no less strict obligation than the private citizen, and if striving after safety not once a year but daily is the duty of every one, we think it is also the duty of the Federal Government.

Not Settled Yet

REPRODUCTION costs must be considered in fixing a value upon railroad properties in this country. That is the gist of the Supreme Court decision in the test case of the St. Louis & O'Fallon Railway against the Interstate Commerce Commission handed down Monday. What weight should be given to such costs the court does not say. It sidesteps that important question by observing that "the weight to be accorded thereto is not the matter before us." It does, however, add: "No doubt there are some, perhaps many, railroads the ultimate value of which should be placed far below the sum necessary for reproduction." And so we are back about where we started. The railroads have won their contention that the value placed on their property must include the cost of reproducing it at the time the the valuation is made, and the Interstate Commerce Commission has been rebuked for attempting to act as "an arbiter in economics" rather than "an agency of Congress." But the railroads' victory means nothing to them because the weight which the commission must give to reproduction costs is not specified and may be nothing if the commission is so inclined, and the commission may disregard the rebuke because it still has a free hand in fixing final values so long as "consideration" is given to reproduction cost. The decision is less definite than the public has the right to expect from the Supreme Court of the United States.

Noteworthy Tunneling

SINCE the inception of shield tunneling the basic elements of the method have changed little, but its results have steadily improved in speed and safety. The latest product of shield work, the Fulton St. subway tunnels under East River, New York, illustrate this progress anew, for their average daily progress of 17½ ft. per heading under 35 lb. air pressure represents a new speed record in shield driving through sand and clay, exceeded slightly only by the progress made through silt in the Hudson River tunnels twenty years ago. One of the twin 18-ft. tunnels under the river has been holed through; headings in the other will meet in a few days. Equal in importance to the speed record is the remarkable freedom of accidents on this job. Pressure tunnel driving is always hazardous, and in the past accidents regularly took a heavy toll of life. Yet in both the land and river tunnels on Fulton St., with eight shields working at once, but one fatal accident has occurred, and that due to a runaway muck car on a steep grade. This safety record is a credit to New York State's most strin-

gent compressed air laws and to the caution and vigilance of the contractor. Again it has been shown that working conditions providing the utmost in safety tend to produce faster and more efficient work. A capable organization closely following details has been well paid in speed and safety. Both records are well worth emulating.

Requiescat

THE TALL concrete monolith which survived the St. Francis dam debacle last year has been dynamited, as noted elsewhere in this issue: a violent ending at last for the sturdy fragment of this unfortunate structure. Much speculation and, indeed, much constructive discussion arose from the fact that this highest part of the dam was the one portion to remain standing when all the remainder of the structure collapsed. The St. Francis disaster produced analytical thought among engineers the world over: the whole subject of dam design and construction was stimulated. *Engineering News-Record*, for example, published nineteen editorials on dams in the twelve-month period following the St. Francis disaster. Long after the public has forgotten the St. Francis dam its influence will be a warning in engineering and construction practice—a deterrent to risk. It may be that in the period after the disaster the remnants and the evidence they bore fulfilled a purpose more important than the service rendered during the few months of functioning as a storage dam. Los Angeles city officials have taken a broad viewpoint in unreservedly providing data for visiting engineers, but the monolith that remained standing could not serve a useful purpose indefinitely. All needs for thorough investigation had been served; mere morbid interest should not be encouraged. Thus there came a time when it was better that the unsightly wreck be removed; no longer to be a mecca for the curious. The structure itself is now gone. The lessons to be learned from it will stand forever.

A Difficult Foundation

GROUND conditions of unusual character were successfully handled in the foundations for the Internal Revenue and Department of Commerce buildings now under construction at Washington, D. C. A layer of quaking clay overlying harsh gravel containing artesian water presented about the most unsatisfactory of all conditions for putting in foundations of concrete piles cast in place. The clay multiplied the chances of disturbance to freshly concreted piles when driving adjacent pile shells, the gravel made a fine rasp for tearing the shells, and the water in its escape through the shells did all else that was necessary to make pile placement a burden on the engineer and contractor. The correctives employed are clearly described in the article in this issue. Obviously they are less significant than are the implications of possible hazard to the integrity of concrete placed under similar conditions without the most careful watch and guard of methods and results. This exacting scrutiny was maintained at Washington, and there is no reason to question that good concrete did not result. But in no degree should the fact be disregarded that the result was due to meticulous control. A lesson again observed in these operations is the danger of upflowing water in placing concrete. Sealing with concrete is a common procedure in foundation work involving springs and other bottom inflows of water. It is an entirely sound procedure where the concrete of the seal is not an integral, strength-giving element of the structure as it is in a cast-in-place pile or the bottom of a reservoir or conduit. Then every experience points to the conclusion that the duty of the concrete in the seal should be limited to its sealing function. There are situations doubtless where the rule can be varied from; this is a matter for engineering judgment. Its exercise should however, invariably be predicated on the certainty that concrete placed to hold down and drive aside an upflow of water is concrete which in some measure has been damaged in exercising its function.

Charting Our Course

AN UNPRETENTIOUS little pamphlet just issued by the Department of Commerce lays before the world the results of an undertaking of magnificent meaning and possibilities. It is the report of a committee on Recent Economic Changes, set up by the department a year or two ago in realization of the fact that the high and steadily advancing prosperity of the United States during the past six or seven years is a phenomenon of great import. It seemed that study of this phenomenon might reveal new facts and laws, perhaps be able to change the whole course of the world's economic future.

The committee's findings justify the inquiry. They appear of utmost value, at least in revealing the nature and a few of the causes of our recent progress. While the future alone can tell how far these findings may help in stabilizing the course of the coming years, there is real promise that the final sequel of the report will see this success attained.

What has been our course during the half dozen years? This is the first of the two questions involved in the report. The answer is summed up in a number of statements: Our national production has grown constantly; the productivity of each worker has increased even more; the use of power per capita has gone up at a high rate; the individual's income has kept ahead of price changes; prices as well as wages have been highly stable; the per capita consumption has risen progressively to a point far beyond what has hitherto been believed the natural limit of human wants, and because of this the whole population has continued in uniform, active production.

It is obvious that each of these statements is highly significant. Which, however, is the basic moving factor? It appears that the key position is occupied by that group of observed facts which includes our growing consumption per man and our stability of price and wage. The first-mentioned, the committee finds, represents the natural yet quite unexpected truth that human wants have almost no limit, and if given opportunity will cause consumer demand to grow indefinitely. It follows that so long as our national producing capacity remains well ahead of actual production and is readily capable of further increase, there need be no decrease of prosperity and no check to progress provided the stability which makes possible a large consumption can be maintained. The basic element, then, is the stability which keeps price and wage in a healthy relation.

We come here to the second question before the committee, namely, how a continuance of this stability and hence of prosperity may be assured. The answer is not definite. The factors responsible for the stable adjustment which is found in the recent past and the present are still elusive. Hence it is not possible to indicate

what shall be done to maintain the balance. As every one knows, our national principle does not permit of price or wage stabilization by fiat, but leaves this function to the interaction of supply and demand. Therefore, if any cause should bring about reduced employment, we know that it will tend to depress wages, will curtail consumption, and will reduce production more rapidly than price, leading on toward an unbalance of the adjustment which the report finds to be the main characteristic of the current economic epoch. On the other hand, if some way can be found to maintain the income distribution which assures maximum consuming power, production will spontaneously be kept up to a high pitch.

In these facts and in the major riddle left for the future, lie a prime reason why the report should be studied by every thinking citizen. The present paragraphs can merely point to the main objective of the report, with a view to urging it on the attention of every reader. Each will conclude, we believe, that in the facts brought out by the committee lay the foundation for great future developments in applied economics.

Serious Aspects of the Cairo Flood Problem

CERTAIN facts of wide implication are pertinently connected with the subject of the Missouri floodway, to which part of the present issue of *Engineering News-Record* is devoted. The guarded statements of the article which we publish may not appear to picture a grave situation, but careful reading will disclose the contrary. The construction of the floodway is to be immediate, bids having been called for May 22. Should any reader living far from Missouri think the floodway none of his concern, he might recall that every engineer is concerned to the extent of at least $50 (a minimum estimate of what every family in the nation must contribute to carry out the Mississippi River flood control) and that the very soundness of engineering method along the Mississippi and of public works administration in general is intimately involved.

The Bird's Point-New Madrid setback, or Missouri floodway, was devised to protect Cairo from floods. It is proper to ask whether it will do so. It gives Cairo's levees a 12-in. freeboard, and whoever has seen wind-blown waves lapping over a levee at even 3-ft. freeboard may easily interpret this 1 ft. in terms of safety. The floodway gives this qualified degree of safety only in case of a "probable" extreme flood, not the possible extreme; and we may properly bear in mind that the unpredicted difference between what is thought probable and what is possible has often brought disaster to the Mississippi Valley, most recently in the great flood of two years ago, which laughed to scorn all the successively higher levee grades established in the past. It seems then, that Cairo's levees will not be made safe by the floodway.

Quite apart from levees, Cairo's main danger lies in the inflow of water through its low ground, threatening destructive sand boils. Even this spring's so far mild floods have produced dangerous boils. The floodway will give no protection whatever from this hazard. If ever the hazard is eliminated by filling the city area, the floodway will have outlived its main usefulness.

Thus, safety is not fully attained even if the floodway operates as planned, and of course still less if it fails to do so. There is real likelihood of the latter contingency. Operation is based on a guessed-at flow-factor through the broken, wooded country of the floodway, and on the hoped-for sufficiently wide washing out of the lowered levees at the head of the floodway, the so-called fuse plugs. In other words, artificial crevasse formation is depended on to bring the water into and out of the floodway, and the indeterminate but very low velocity of flow through wooded bottomlands is depended on to divert a volume large enough to lower the water plane within an accuracy of 12 in. Unless these two guessed-at factors work out, the Cairo levees are overtopped.

The Cairo problem is intricate. So difficult was it regarded by the Mississippi River Commission after the 1927 flood that, while outlining a full project for the protection of the valley, the commission would not make a recommendation for this reach of the river but advised more thorough study, requiring much longer time. The Chief of Engineers however, put two weeks of study upon it and decided upon the floodway. It appears from what is pointed out above that the commission's attitude was wise.

In the past year, it will be presumed, the project has been thoroughly restudied and the Chief of Engineers' decision confirmed. Also, the Jadwin-Jackson-Sturtevant Board of Review may have scrutinized the problem and verified the correctness of the solution. Unfortunately, neither presumption is true. The Board of Review admitted that it had not studied the best plan for protecting the valley as it was directed to do, but had merely compared the Jadwin plan with part of the commission's project, endorsing the Jadwin plan in each point. Such study as has been given to the Missouri floodway during the past year by the field forces is confined to routine detail; the sufficiency or merit of the plan itself has not been reviewed, for the plan was prescribed. This is no reflection on the ability or sincerity of the engineers on the ground, but merely means that they worked under orders—the orders of a rigid military bureaucracy which permitted no excursion beyond the boundaries laid down.

An issue fully as broad as that of the efficacy of the plan is its economic value: What does it cost, compared with what it is intended to save? This also has not been studied. An area as large as a great federal reclamation project is to be laid waste by the floodway, and most of this area at present is fertile land; but the economic loss of destroying this land and evicting its population has not been placed in the reckoning against other forms of relief for Cairo. In fact, even the cost has not been determined, and such effort as has been made to obtain a valuation of the land takings has been based on methods locally denounced—and apparently with some reason—as something near to sharp practice.

Thus, the entire situation with respect to the Missouri floodway is in the highest degree unsatisfactory and regrettable. It cannot forward the solution of the Mississippi problem, but it bears the threat of bringing obloquy on those who have dealt with it, and by reflex on other national public works.

For all these reasons the haste in putting the floodway under contract is unseemly. Since it would not be illogical to begin at the mouth of the river and progress upstream in providing increased discharge capacity for floods, time for study of the Cairo problem can readily be obtained. We shall continue to hope that this study will yet be made. If the Army engineers themselves do not reconsider their action, Congress or even the President will be warranted in halting the present proceedings.

The First of the Mississippi Floodways

A Field Study on the Eve of Construction of the Missouri Floodway—Engineering and Economics of the Proposed By-Pass From Birds Point to New Madrid—An Estimate of the Degree of Protection for Cairo

By W. W. DeBerard
Associate Editor, Engineering News-Record

AT THE HEAD *of the Mississippi River's alluvial valley lies the city of Cairo, Illinois, almost ringed around by the Ohio and the Mississippi rivers. Here centers one of the most difficult and most bitterly disputed elements of the valley's flood protection. The Jadwin plan which is now being carried out aims to protect Cairo by a by-pass channel on the west bank. How was it planned and what are the local conditions?*

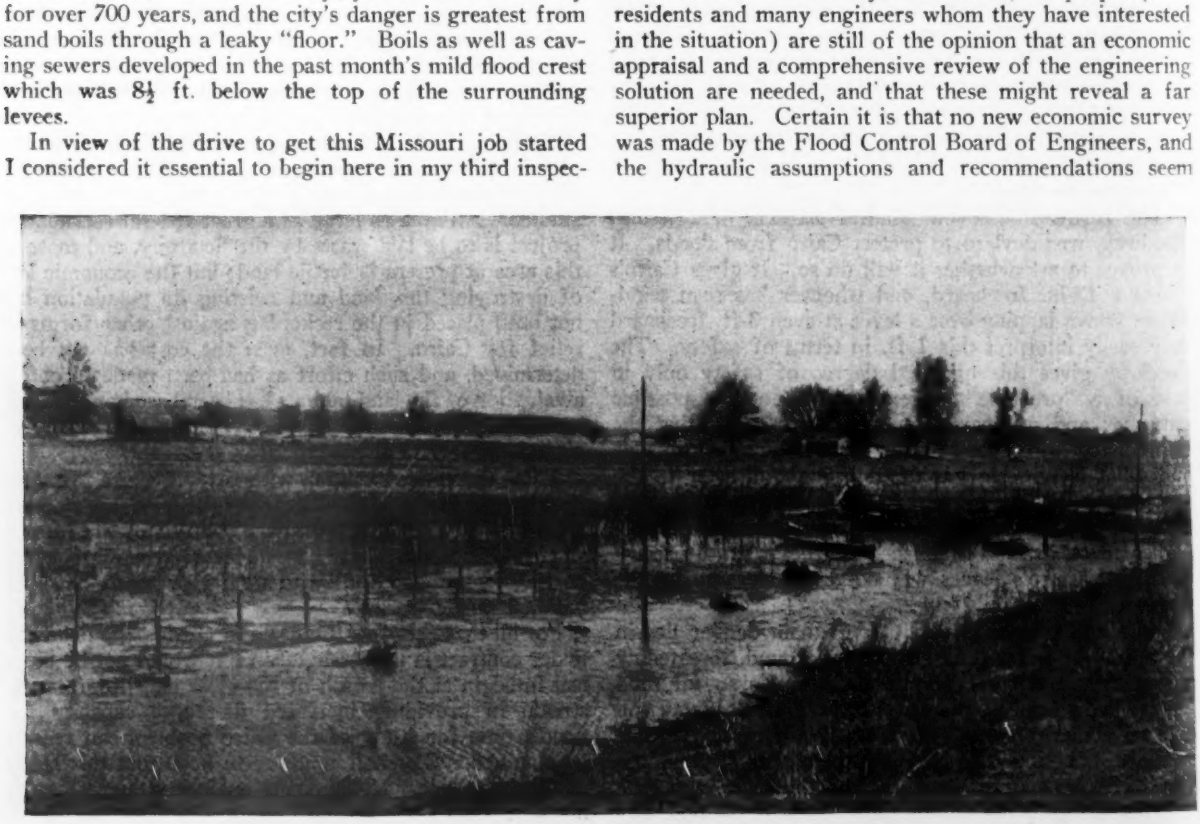
BASIC data for the design of the by-pass, known as the New Madrid floodway, in Missouri, were obtained by the engineers of the Mississippi River Commission in surveys of the floodway area last fall. One of the most controversial features of the whole project, this floodway has engaged the attention of civilian engineers as to its adequacy, of Congressman and state officials as to its legality and of politicians as to its expediency. Work on the project has been hurried, and bids have been received, although land for the set-back levee is still in course of acquirement and information on which to work out a payment basis for flowage rights is still being gathered. The imminent danger to Cairo is the stated reasons for this hurry; yet Cairo has been dry for over 700 years, and the city's danger is greatest from sand boils through a leaky "floor." Boils as well as caving sewers developed in the past month's mild flood crest which was 8½ ft. below the top of the surrounding levees.

In view of the drive to get this Missouri job started I considered it essential to begin here in my third inspection of flood-control activities. The problem involved is of the first magnitude, and after ten days driving over the floodway area, interviewing officials, farmers, lawyers, bankers, merchants and engineers, I can report that the complexity and difficulty of the situation were by no means overstated in my former article in *Engineering News-Record*, Feb. 23, 1928, p. 311.

The officially adopted project calls for a floodway approximately 5 miles wide from Birds Point (opposite Cairo) to New Madrid, a river distance of 70 miles and a distance of 35 miles along the floodway axis. It is to have a "fuse-plug" inlet and outlet through sections of the present levee, which will be truncated to a level 5 ft. below the top of the Cairo levees (which are at 60 ft. on the Cairo gage). A guide levee set back from the river levee and roughly parallel will delineate the west bank of the floodway. These details are shown by the maps.

The Floodway Project and Studies

Only meager data were available when the general project was determined upon and aroused criticism. Even after the extensive surveys since made, the people (local residents and many engineers whom they have interested in the situation) are still of the opinion that an economic appraisal and a comprehensive review of the engineering solution are needed, and that these might reveal a far superior plan. Certain it is that no new economic survey was made by the Flood Control Board of Engineers, and the hydraulic assumptions and recommendations seem



SAND DEPOSIT IN FRONT OF DORENA CREVASSE LEAVES DESERT WASTE

essentially the same as those of the Chief of Engineer's original report to Congress.

The Problem—Cairo lies within a ring of levees. In high-water periods the 16,000 people live in an empty reservoir surrounded by water 15 to 27 ft. above its floor. For the future safety of Cairo against overtopping by possible floods of 2,250,000 to 2,400,000 sec.-ft. three remedies are available: (1) Raise the levees; (2) raise the entire city area, and (3) lower the flood plane. The last plan was adopted, probably for reasons not all of which can be called engineering. However, few projects are decided entirely from the engineering standpoint. At any rate a plan, this riverbank, fuse-plug-floodway plan, is now considered beyond discussion in the offices of the Army engineers.

The essential starting points of the detail calculations are: A maximum flood of 2,400,000 sec.-ft. at Cairo, and reduction of the flood plane at Cairo to at least 59 ft. or 1 ft. below levee tops, and of the New Madrid flood plane to 51.5 ft. on the Cairo gage. Accordingly the engineers had to figure backwater curves beginning at New Madrid and by cut-and-try procedure arrive at the stipulated Cairo height.

Surveys—Ten miles of the floodway length at its upper end are comparatively flat, and this is the critical section. Two minor ridges and a third major ridge (O'Bryans ridge) cross this section almost at right angles. From the third ridge at the lower end of the section, the ground drops off some 15 ft., and thence downstream both ground slope and floodway width increase sufficiently to eliminate the lower section at a controlling factor with respect to Cairo. Therefore in the upper stretch, 1-ft. contours were taken as far as the Missouri Pacific Railroad (Belmont Division), while in the lower reaches only 5-ft. contours were taken. In the upper stretch cross-sections were plotted approximately a mile apart, across both floodway and river channel to the bluff or the levee on the Kentucky side. For the lower section similar cross-sections were platted at 2-mile intervals.

Backwater Curves—Four conditions were assumed in calculating backwater curves, after a location of the set-back levee had been chosen as shown by the maps, with 11½ miles of fuse-plug section at the upper end and a 5-mile outlet fuse-plug section at the lower end. The assumptions were (1) free flow from floodway to river channel as though the present river levees did not exist; (2) unimpeded flow into the floodway in the upper fuse-plug section, flow divided by the river levee for the next 21½ miles, and unimpeded flow thereafter; (3) weir flow over the inlet fuse-plug; and (4) crevasses in the inlet fuse-plug reducing this weir head by half.

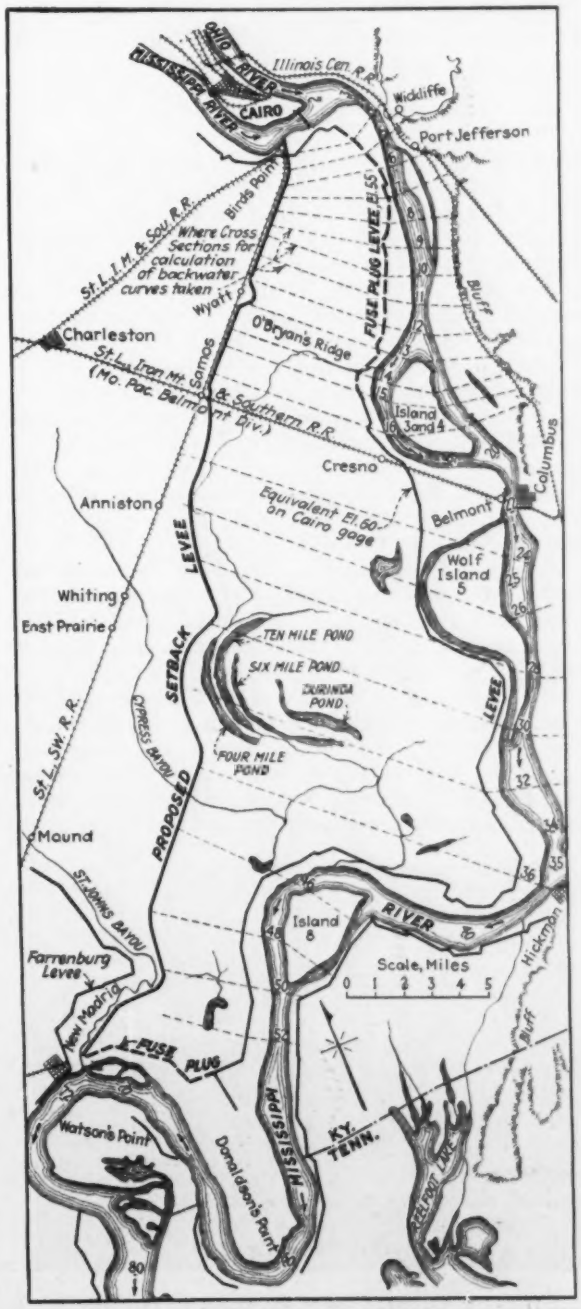
Discharge over the levee as a submerged weir was calculated by a modification of Molitor's formula,

$$Q = (1.57H_2 + 3.21H_1)\sqrt{H_2}$$ (see Fig. 4).

The roughness factor n in Kutter's formula was determined for the river channel from the 1927 flood, which had a measured discharge of 1,800,000 sec.-ft. at Cairo and well-marked highwater elevations every mile on the levee bank, giving slopes; assuming $n = 0.120$ for the overbank flow, its volume was determined and subtracted from the 1,800,000 total, and the channel flow so deduced gave a figure for n in the channel.

For the floodway reach below the Missouri Pacific tracks, the timbered and cut-over areas were estimated from the survey as 75 per cent of the total area. Taking n as 0.150 for timber and 0.060 for cultivated land (both figures obtained from observations of flow in the St. Francis floodway reported by C. E. Ramser in *Engineering News-Record* of April 5, 1928, p. 541), a new, single, weighted average $n = 0.120$ was derived. Above O'Bryan's Ridge, by similar weighted averaging between $n = 0.60$ for 75 per cent cultivated and $n = 0.150$ for 25 per cent timbered area, an average $n = 0.070$ was deduced.

If the map on which the timbered areas are shown is inspected certain minimum sections will be found where the flow would encounter as high as 50 per cent timber obstruction, but this is not so serious as is the prediction of the local residents that the whole area will soon be covered with an undergrowth of willows after the first operation of the floodway. On this point of opinion



BIRDS POINT-NEW MADRID FLOODWAY TO RELIEVE CAIRO WHEN HIGHWATER REACHES 55, OR 5 FT. BELOW ITS LEVEE TOP

CUTOVER TIMBER LAND IN LOWER FLOODWAY
Little value will be left after timber is logged off and land will doubtless be abandoned for taxes; *n* will be high here.

rests the question of the success or failure of the floodway. A low *n* for a cleared floodway, will carry the designed capacity and hold down the flood plane at Cairo, but if timber clogging raises the value of the roughness factor the reduced plane at Cairo will not be attained.

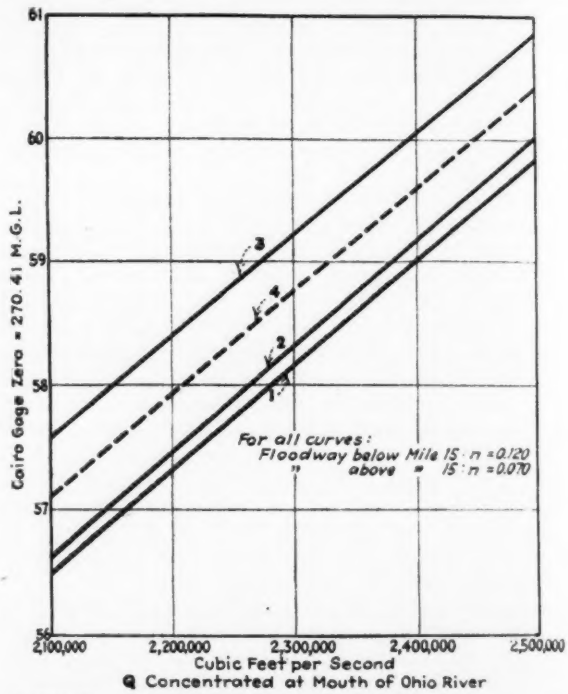
Assurance of clearing is therefore essential in the upper 10 miles of critical section. That thousands of acres have for years been kept clear and cultivated on the riverside of levees subjected to every flood is one of the strong arguments favoring the idea that this inside area subject only to floods greater than 55 ft. will be cultivated. On the other hand good land opposite the Dorena crevasse of 1927 after two years shows dense willow growth 10 ft. high. At any rate the imperative need for a cleared, perpetually maintained floodway confronts those in charge of flood-control operation.

Results of Computations—The laborious computations indicate that with the floodway in operation 2,250,000 sec.-ft. will pass Cairo at 58.4 ft. elevation and 2,400,000 sec.-ft. at 59.6, or 2,325,000 sec.-ft., at the limiting flood height of 59. The same calculations also fixed the grade of the set-back levee which was based on the 2,400,000 flood. Uncertainties in determining the grade of the flow line are the extent of crevasses in the upper fuse-plug section and uncertainty as to how the cross section should be projected from river-channel to set-back levee. Two adjustments were therefore made: The composite

WILLOW GROVE 8 TO 10 FT. HIGH IN FORMER ALFALFA FIELD
This land is in the path of the Dorena crevasse discharge. This 2-year growth can be ploughed under, but not after another year.

flow lines at the river as computed for the four assumed cases were projected across the floodway on the line of the assumed cross section, the highest water line being taken in each case, and this point was then moved down the river a safe distance along the set-back levee.

Entrance to the Floodway—Final location of the set-back levee placed its upper end east (downstream) from Birds Point, a terminus of the Cotton Belt Railroad and the landing of the Cairo ferries. This location is upstream from the end of the new highway toll bridge, whose west approach will be within the floodway; it is planned to raise this approach or else arrange for use of the main levee upstream to the junction with the set-back levee, in order that the people of Cairo may have safe exit in time of extreme floods. It should be recalled that



1• *Free flow. Present levee assumed non-existent*

2• *Free flow below Mile 36 and between Miles 3 and 14½. Constant divided flow between Miles 14½ and 36*

3• *Free flow below Mile 36. Constant divided flow between Miles 14½ and 36. Fuse plug Miles 3-14½ assumed to act as a weir*

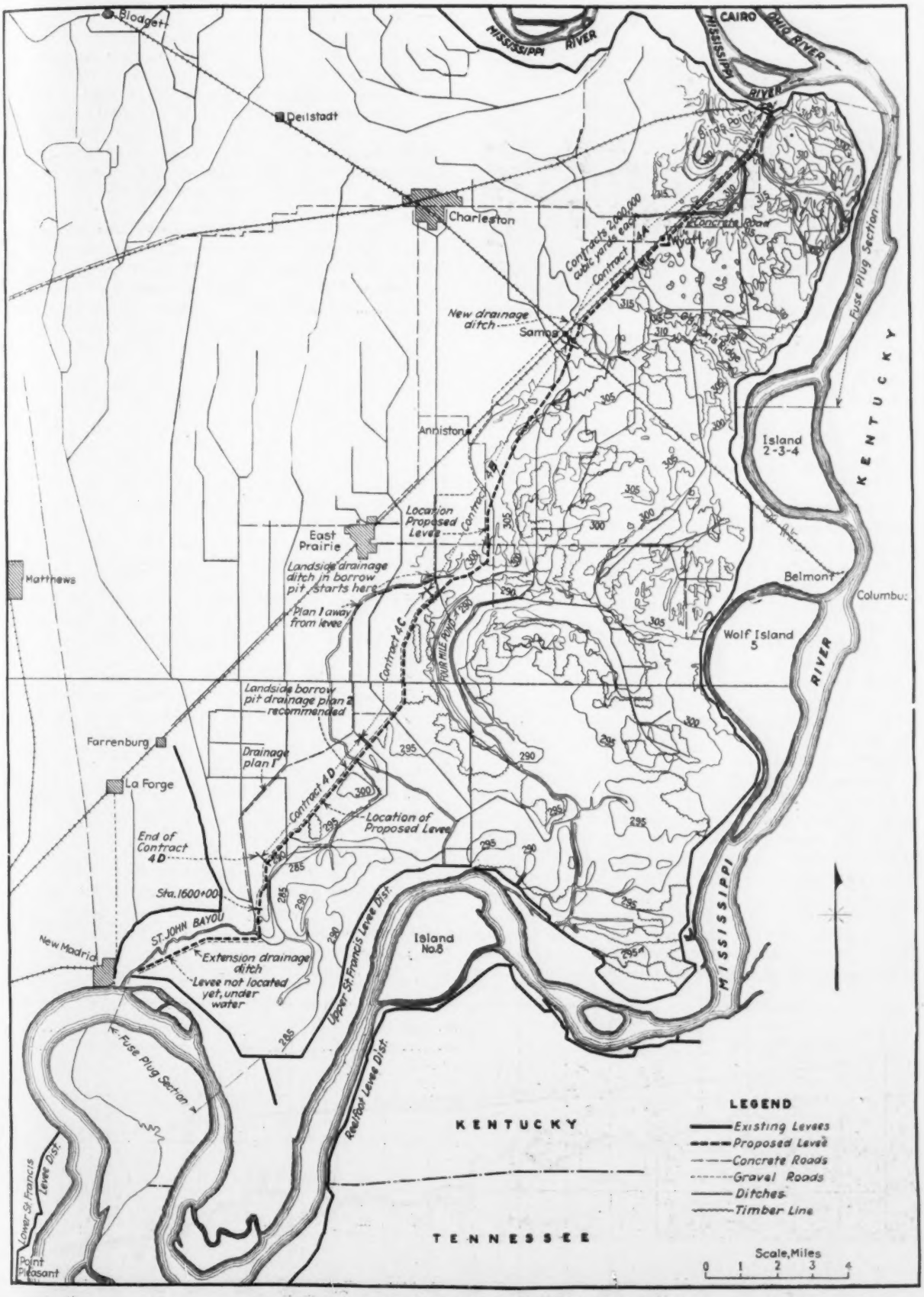
4• *Assuming weir head effect of fuse plug Miles 3-14½ to be reduced to ½ by crevasses*

GAGE HEIGHTS TO BE EXPECTED AT CAIRO WITH FLOODWAY IN OPERATION UNDER FOUR ASSUMPTIONS

the main highway route from the city will be barred if the steel floodgate across the road at the Illinois Central embankment is lowered to cut off water from breached levees north of Cairo.

Will the Floodway Work?—The plan to swing the upper end of the set-back levee farther upstream seems to have been abandoned after the first preliminary study (in which the lower end of the floodway was terminated only 10½ miles below the inlet), although it would take water from above Cairo at an elevation about 4 ft. higher than Cairo and give much more assurance of getting the necessary full amount of designed capacity into the floodway.

Inspection was made of this area and of several of the 1912 and 1913 crevasses south of Big Lake, which in effect were the fuse-plugs during the floods of those two



TIMBERED AREAS, CONTOURS, DRAINAGE DITCHES, ROADS AND SET-BACK LEVEE DEFINING FLOODWAY

HOUSE ON O'BRYAN'S RIDGE ABANDONED DUE TO SOIL BEING WASHED AWAY

O'Bryan's Ridge extends entirely across the floodway. Scour in 1912 and 1913 cut the soil to clay, 6 to 24 in. deep, rendering several sections of no use for farming.

years, both of which rose to higher volumes than the 1927 flood. After these floods the present new levee was constructed, its top being at 60 ft., whereas the old one was at 52 ft.

Not too much information exists as to the get-away of the water from these 1912 and 1913 crevasses. But there are definitely authenticated highwater marks on the road directly east from Charleston for a distance of approximately 12 miles above O'Bryan's Ridge. Plotting the ground profile under this high-water stage gives a cross-section of 305,000 sq.ft., which flowing at a velocity of approximately 1 ft. a second, would indicate a discharge of 305,000 sec.-ft. for the whole section. These rough figures are given because many engineers have felt that the restricted entrance provided for the adopted project is entirely too limited and the get-away too uncertain in the upper flat reaches, with the probability of increasing timber obstructions.

Mainly however, is the deduction as to a lowered gage at Cairo subjected to question. The 1913 floodway lowered the Cairo gage 1.2 ft. when discharging approximately the amount which it is now planned to by-pass. Will the adopted floodway produce any greater lowering? That is seriously questioned, and on this question hinges the whole justification of the Birds Point scheme!

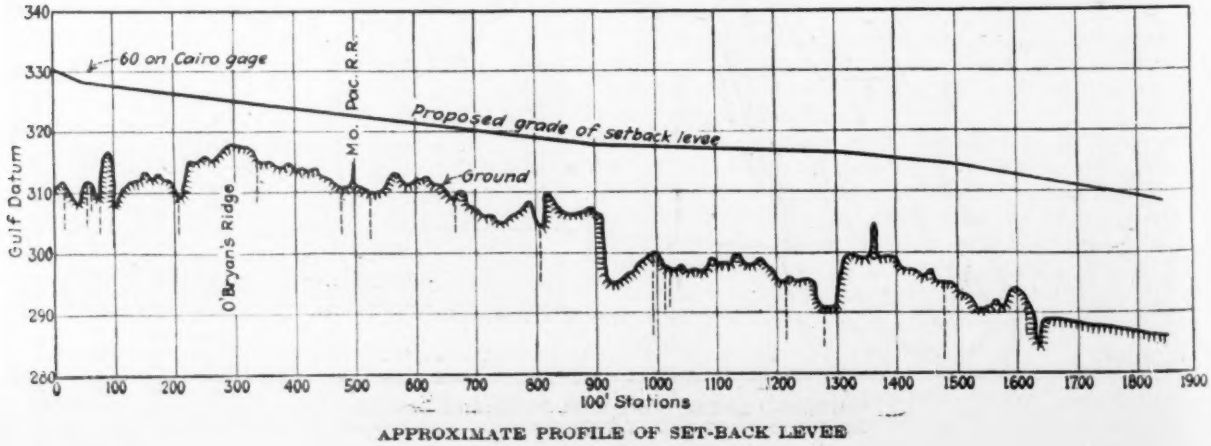
Certain it is that this phase of the matter should be studied more carefully than has been possible in the District offices under the restrictions of the adopted plan. What variants of the scheme are possible, and how might they improve the result? The cost of extra flowage rights, damage to the three railroads (some of which might be glad to be permitted to abandon unprofitable trackage), and the inconvenience to highway traffic from Cairo (which might as cheaply be safeguarded by better and higher levees in Illinois) all should be balanced against the necessity of surer operation of the floodway and the possibility of raising the fuse-plug levee grade. More protection would accrue to the farmers in the floodway if the period between fuse-plug operations were lengthened.

The Set-Back Levee—The set-back levee which delimits the floodway on the west follows southwest along the Cotton Belt Railroad. At Wyatt it swings around the town, and at Samos it turns southerly to avoid the poor foundation disclosed by borings on the original line along the tracks. Below Samos the location depended on foundation and topography (e.g. to get on high ground around Four Mile Pond).

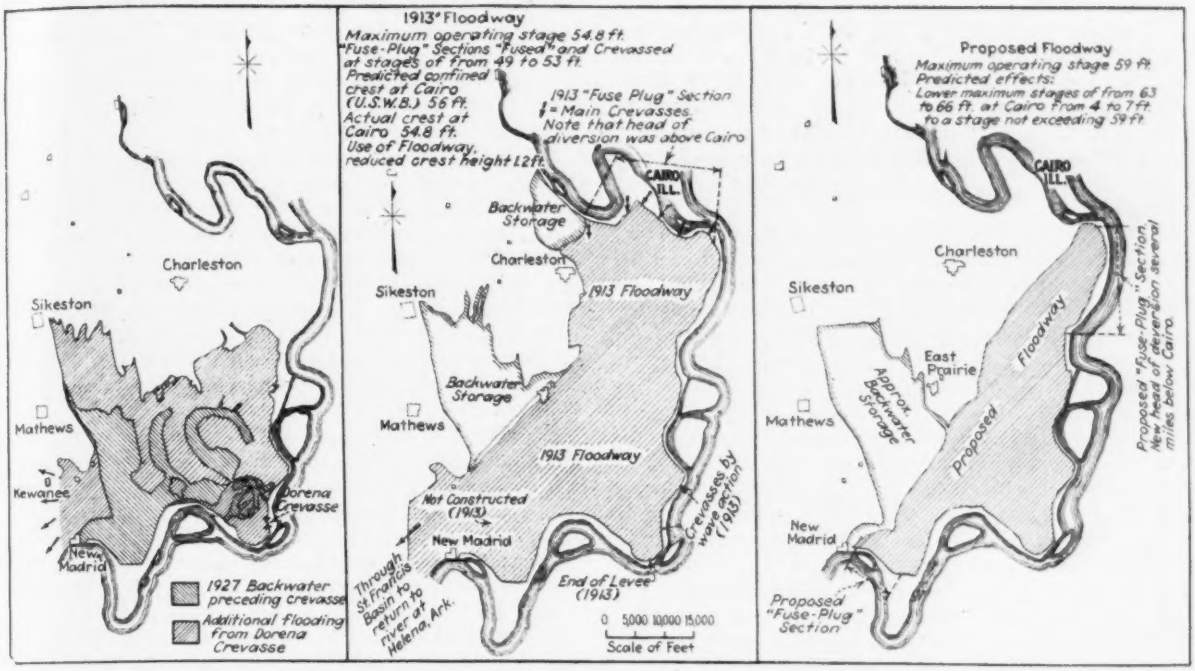
Some question yet remains as to just how far to carry the lower end along St. John Bayou, since backwater at the high stages will have overtopped the main levees up to Hickman and backed up St. John Bayou nearly to the town of Sikeston along the Sikeston Ridge. Placing a floodgate 5 miles above New Madrid across St. John Bayou has been considered; it may be worth while later, when the land values to be protected become greater. Shortening the levee 4 miles would raise the backwater 3 ft., and the Farrenburg levee would have to be raised at a cost of $194,000 to prevent water crossing Sikeston Ridge into the St. Francis Basin. Although the shorter set-back levee would be $720,000 cheaper, damage claims might offset this figure, and the shorter levee was not adopted.

As to foundation, borings have been made at 1,000-ft. intervals over the whole line. Under the superlayers is a fine sand with enough clay to make it extremely fluid but not enough to fill the voids. As this material under pressure flows badly, the levee has been located where a blanket of at least 7 ft. overlies this sand.

The right-of-way width chosen is 462 ft. for the upper 17 miles and 660 ft. for the remaining 18 miles. The crown grade of the set-back levee is to be 1 ft. above the flood plane (59 ft. at Cairo and 51.5 ft. at New Madrid). The crown width will be 10 ft.; the slopes 3½ to 1 on the water side and enough on the back to inclose a 6½ to 1 seepage line. Between stations 0 to 1,000 four back slopes are called for: Up to 10-ft. head, 1 to 5; from 10 to 20-ft. head, 1 to 5½; from 20-ft. and up, 1 to 6. Between stations 1,000 to 1,500 the heads



APPROXIMATE PROFILE OF SET-BACK LEVEE


1913 Floodway
Maximum operating stage 54.8 ft.
"Fuse-Plug" Sections "Fused" and Crevassed at stages of from 49 to 53 ft.
Predicted confined crest at Cairo (U.S.W.B.) 56 ft.
Actual crest at Cairo 54.8 ft.
Use of Floodway reduced crest height 1.2 ft.
1913 "Fuse Plug" Section
= Main Crevasses.
Note that head of diversion was above Cairo
Proposed Floodway
Maximum operating stage 59 ft.
Predicted effects:
Lower maximum stages of from 63 to 66 ft. at Cairo from 4 to 7 ft. to a stage not exceeding 59 ft.
Proposed "Fuse-Plug" Section. New head of diversion several miles below Cairo
CAIRO ILL.
Charleston
Sikeston
Mathews
Kewanee
Dorena Crevasse
New Madrid
Backwater Storage
1913 Floodway
Not Constructed (1913)
Crevasses by wave action (1913)
End of Levee (1913)
Through St. Francis Basin to return to river at Helena, Ark.
East Prairie
Approx. Backwater Storage
Proposed Floodway
Proposed "Fuse-Plug" Section
1927 Backwater preceding Crevasse
Additional Flooding from Dorena Crevasse
0 5,000 10,000 15,000
Scale of Feet

AREAS OF THE NEW MADRID FLOODWAY SUBMERGED DURING FORMER FLOODS

Left: Backwater areas and land flooded by the Dorena crevasse in 1927. Center: Floodway taken in 1913 when crevasses operated similar to proposed fuse-plug levees. Right: Area of proposed floodway. About 100 sq.mi. less than that flooded in 1913.

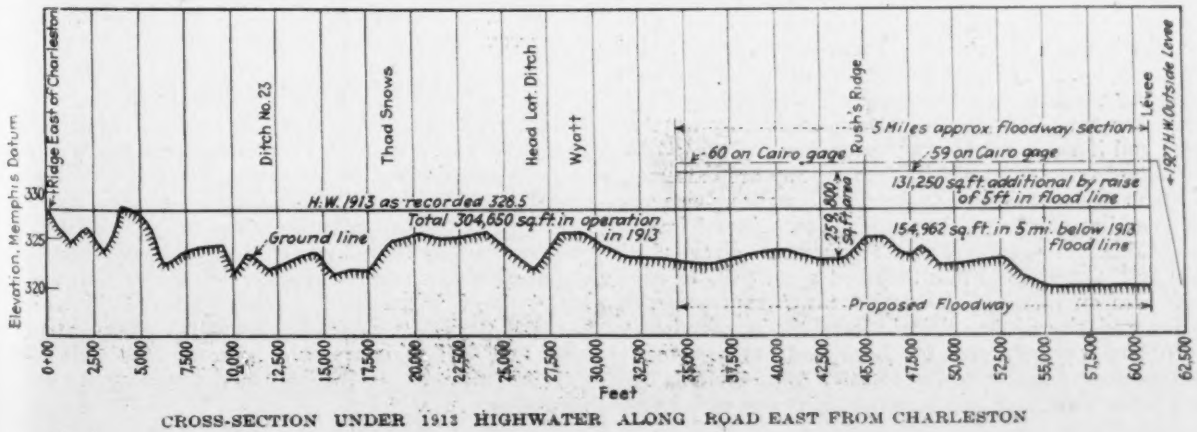
are 8 ft. to 5 ft., and the slope 1 to 4½, while thence to the lower end, with heads below 5 ft., the slope will be 1 to 3½. The highest levee, 20 to 25 ft., occurs at the lower end, but the head difference is small because of the backwater.

Drainage and Silting—Much discussion has arisen over the decision of the engineers to build borrowpits on the landside of the set-back levee from station 990 to 1,640, the pits being used to care for intercepted drainage ditches. A main ditch 1 to 2 miles away from the levee would cost $300,000 more. This portion of the levee will lie almost entirely in backwater during the operation of the floodway to capacity, and as the head is not large the construction is not considered dangerous.

There remains the fact that much money has been spent in this locality to fill up land-side borrowpits which locally are considered hazardous due to horizontal seepage through a stratum of sand which underlies practically all of this area at elevations that will be reached by the depths to which the new drainage ditch will have to be carried to serve the existing ditches. Many of the latter have been filled in from 6 to 8 ft. from these sand strata as well as from side sloughing. Maintenance, cleaning them out and restoring their depth is now overdue because of the uncertainties and straightened financial condition of the drainage districts. The land owners ask what agency will maintain the combined borrowpit and drainage ditch, on government property.

Another maintenance question that appears to be of some moment is that of restoring the drainage ditches in the floodway following the operation of the fuse-plug. A crevasse ordinarily fills miles of ditch with sand. Will the flow from the fuse-plug be less harmful? The original cost of the 100 miles of ditches in this area exceeded $1,000,000. Also there are 11 miles of 9-ft. single-lane and 6¼ miles of 16-ft. double-lane concrete road in the floodway (each with developed drainage), for which state and county paid $440,000; no estimate of damage is available or has been set up.

The Dorena crevasse, which occurred in the lower part of the floodway region, opened into a timbered area, so that the sand flow was checked and deposited rapidly.



CROSS-SECTION UNDER 1913 HIGHWATER ALONG ROAD EAST FROM CHARLESTON

However it filled canals from local wash as far away as 5 miles. Last year I observed large drainage and roadside ditches more than 5 to 10 miles from the Mounds Landing crevasse bank-full with sand and silt. From the standpoint of early deposition the timber barrier which flanks most of the 11½ miles of the fuse-plug, will be of decided help. But for the same reason it may reduce the water in flow and upset the whole floodway calculation.

Fuse-Plug Levees—Entrance of water to the floodway is to be made by way of an 11½-mile section of existing levee cut down to Cairo stage 55, or 4 ft. below the flow line of the 2,325,000 sec.-ft. flood. It begins 1 mile below the approach of the new bridge, thus insuring no major disturbance from a crevasse nearer than that distance.

Similarly, the outlet is by way of a 5-mile section of cut-down levee. This latter will have no effect on extreme flood stages at Cairo, since the lower end of the existing levee is below the computed flow line.

Summary—So much for the hydraulic and engineering features of the problem. After reviewing them one cannot escape the feeling that the project suffers from incomplete study and information. It is true that the detailed design work of the New Madrid floodway has been done very well; but no engineer is likely to be satisfied with the absence of basic data on flow coefficients.

The Lands in the Floodway

Certain human interest and economic problems crowd in on one's consciousness in traveling through the floodway country.

This region is extremely flat, with drainage toward the river for the few miles above O'Bryan's Ridge but below this point away from the river (as is typical of the great portion of the valley). Farms, fairly well cared for, are planted to wheat, alfalfa, corn and cotton. Hogs and cattle are only fairly well represented. As classified by the Army engineers the area includes nearly 53 per cent timber and cut-over lands and 45 per cent open lands. How these lands are to be valued equitably is a matter of some concern to both engineers and residents.

ESTIMATED CLASSIFICATION OF LANDS IN THE FLOODWAY AREA

Kind	Above Backwater, Acres	In Backwater, Acres	Total, Acres	Percentage	
Lakes, open water, etc.	139	48	187	0.14	2.4
Swamps and marsh	565	2,416	2,981	2.3	
Timber land	110	20,108	20,218	15.4	52.7
Cutover timber land	10,378	38,771	49,149	37.3	
Farm land (cultivated)	35,990	13,815	49,805	37.8	44.9
Farm land (not cultivate)	7,683	1,665	9,348	7.1	
	54,865	78,823	131,688		
	41.6 per cent	58.4 per cent		100 per cent	

Recently the engineers sent the land owners a card on which to note their own classification of their holdings and the assessed valuations. An airplane photographic survey is about to be made. From these sources added to the field survey the facts as to classification and total assessed valuations will be obtained; then damages will be estimated and settlement attempted first by negotiation and if necessary by court procedure.

Actual values of lands in the floodway are extremely difficult to determine, since there is no market value and returns have been low in recent years. Actual investment deserves consideration. The owners of several of the best places stated that they had spent $100 to $150 per acre on clearing, tile drainage and improvements, often exclusive of the original cost of the bare land.

A large percentage of the farm land has been mortgaged, usually at $50 to $75 per acre. Loans coming due are being foreclosed unless part cash is put up. Large tracts are being taken over by insurance and loan companies and operated by farm managers. Two good crops at good prices will put many of these farms on their feet but they will practically all be tenant-operated, and the area will thus be lost to the home-making element.

A Cairo banker when asked about these conditions stated that all of southeast Missouri is in the same condition; few new loans are possible, and indeed the owners in the floodway are a better risk than those outside since there is the prospect of actual cash forthcoming from claims. Others added that the claim moneys have long ago been encumbered by loans and the loan money spent beyond recall. The prospect that construction will bring in a lot of money is a poor reliance, and only the gas stations and personal service merchants are likely to benefit materially, said an engineer. Thus does local opinion vary.

Farming Will Decrease—My own opinion is that the extent of future farming depends on many factors. At first the fuse-plug operation will not be controlling. The farmer will put in a crop, provided he has the money to do so. If bank money is tight and city credit stiff the farmed acreage will shrink. Every adverse reaction due to a crevasse or to money stringency or crop failure will cause a further shrinkage in the next year's acreage.

Federal land banks will not loan money in the floodway, and therefore individual farming will progressively go out. Insurance and loan company holdings will persist for many years, but the least profitable pieces and those affected by crevasse-filled ditches will be abandoned. No new cut-over lands are likely to be reclaimed. Owners of the present timber lands such as the 20,000-acre tract owned by the Three-State Lumber Co. in the southern overflow area, west of the Dorena crevasse, will welcome any contribution from the government, cut off the timber and then abandon the practically valueless land. All told, then, the salvage on the floodway area will not be large.

But besides this there are the nearby areas outside the floodway. Consequential damages to this territory will be considerable, and are most difficult to estimate. It is hard enough to estimate loss of trade territory and prospective business, but still harder to decide on compensation. The probable effect is illustrated by the present expectation that two typical towns, East Prairie, (pop. 1,500) and Charleston (pop. 4,000) will lose one-third their population. The total business from the 2,500 people in the floodway may be estimated at from $500,000 to $750,000 per year. Shrinkage of town population will shrink values 25 to 50 per cent. Realignment of taxes and shifting from abandoned floodway lands to lands outside will lay down another heavy burden on outside lands. Must not all these losses be set down in drawing up the economic balance sheet?

Acknowledgment to Engineers

The engineering investigations reveal a remarkable amount of excellent work by the engineers in the office of the Memphis Engineer District of the Corps of Engineers. Col. F. B. Wilby is in charge of this district, but much of the hydraulic study has fallen to the lot of William Parkin, Blair Ross and Henry Bloompot, civilian engineers in the general engineering division, of which Mr. Parkin is in charge. An area engineer, T. T. Knappen, has opened an office at Cairo with a large corps of office and field engineers, who have the field work and working drawings for the construction nearing the contract stage.

Cast-in-Place Concrete Pile Work in Quaking Clay

Heaving, Distortion and Upward Water-Pressure Damages Experienced and Overcome in Driving Over Twenty Thousand Piles for Two Washington Buildings in Marsh Ground

By Neal A. Melick

Construction Engineer, Office of Supervising Architect, Treasury Department, Washington, D. C.

Two remarkable pile foundation operations are analyzed in this article. The number of piles in each foundation is large, the subsurface soil and water conditions were difficult and the piles were of concrete cast in place. Exceptional subsurface conditions intensified the normal problems of casting piles in the ground. Heaving, weaving, distortion by lateral pressure and disruption of placed concrete by upflow of water were encountered. The extent and cause of these actions, and the ways adopted to decrease their hazard to the pile structure, constitute an instructive study; it is presented with unusual skill in narration. —Editor

IN THE EARLY days of Washington, when the lands on the south side of Pennsylvania Ave. were known as "the marshes," there ran through these marshes a little stream called Tiber Creek. In time Tiber Creek grew up and became the Washington Canal, developed for the use of planters and fishers from Chesapeake Bay and the Potomac River for marketing their products in Washington. Later all trace of the canal was obliterated by filling it in, and buildings and streets grew where the marshes and the Tiber had been. Now the federal government is down there tearing out the old buildings to erect the monumental Internal Revenue and Department of Commerce buildings, and the old marsh lands necessitate expensive foundation construction.

Both foundations are concrete piles cast in place by driving steel shells and filling them with concrete. The Internal Revenue Building required 8,000 piles ranging in length from 15 to 42 ft. and averaging 26 ft. About the same pile lengths were employed on the Department of Commerce building and 13,500 piles were driven. For those who are intrigued by that kind of statistical statement it is mentioned that 40 miles of piles were driven for the smaller building and 60 miles for the larger. A hundred miles of concrete piles for two buildings may not overtop all records but it looms up as an accomplishment of parts. The entire amount was driven in eight consecutive months.

Somewhat more significant statistics, because they indicate the effect of the underground hazards that were encountered, are provided by the shell consumption records. The common allowance of the pile contractors of much experience who did the work is 108 shells for

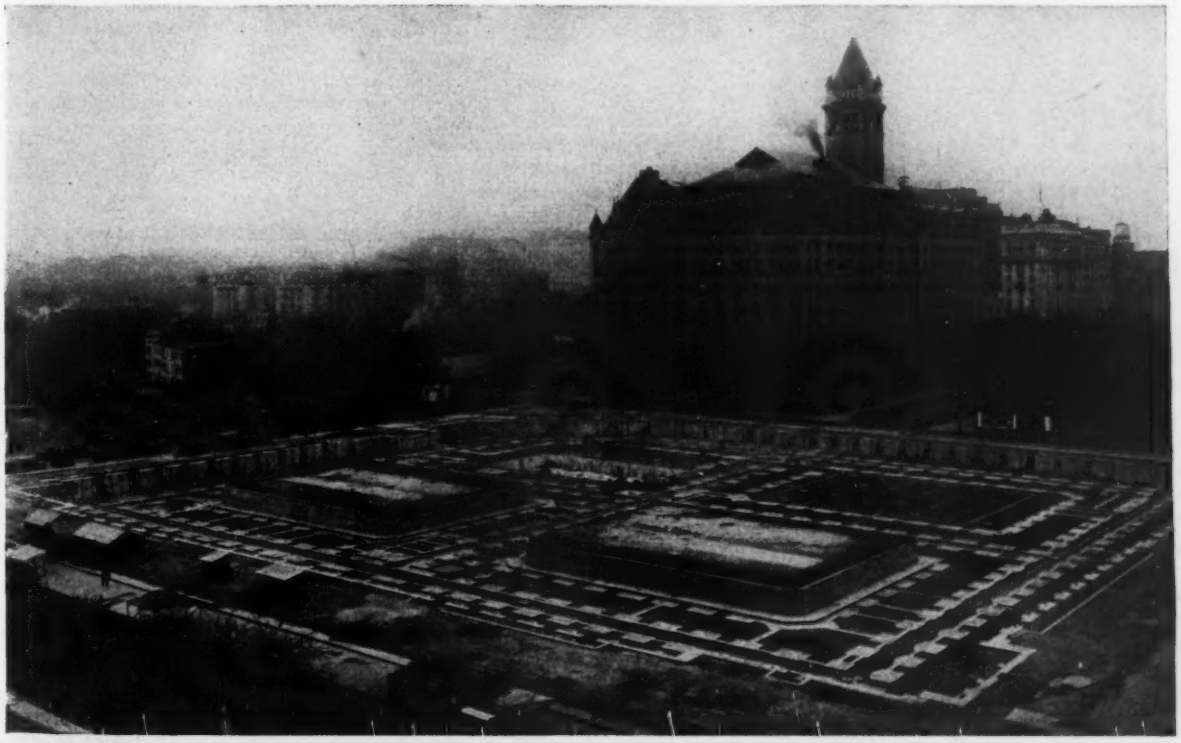


FIG. 1—COMPLETED FOUNDATION FOR INTERNAL REVENUE BUILDING, WASHINGTON, D. C.
The visible footings are carried on 8,000 concrete piles cast in place and averaging 26 ft. long. The piles cost $1.82 per foot and the foundation cost $82 per pile.

100 completed piles. That is eight shells are wasted for each hundred piles molded. On the Internal Revenue Building the shell consumption was 132 per cent and on the Department of Commerce Building it was 149 per cent. These two foundations are shown by Fig. 1 and Fig. 2 respectively.

Subsurface Soil and Water Conditions— From street level to basement floor (approximately tide level of the Potomac River) the excavation was mostly filled material. Part of it was natural clay. From basement floor down for a variable distance of 8 to 10 ft. there was what was called swamp muck—a material somewhat like peat,with the vegetable fibers showing. Below this was a stratum of non-waterbearing compact hardpan

FIG. 2—CONSTRUCTION OF FOUNDATIONS FOR DEPARTMENT OF COMMERCE BUILDING, WASHINGTON, D. C.
This work now under construction calls for 13,500 concrete piles molded in place.

and gravel, varying in thickness from 1 ft. to 3 ft. over the entire site, and this gravel stratum proved particularly troublesome. Next below was a fine soft clay, some of it a brilliant green, and in the green there were pockets of white. Below this, at irregular depths, there was gravel, having an undulating surface that sometimes was very abrupt in its changes. In places it was sand, very sharp and so clean and well graded that it could be used as a building sand.

The underlying sand and gravel stratum proved to be a water basin with the water sealed in tight by the overlying clay, hardpan, peat and fill under a hydrostatic pressure sufficient to force the water up into the excavation wherever the seal was broken. Holes for test borings became flowing wells; piling casings not absolutely watertight were filled and in many cases the water overflowed the casings even though they extended several feet above the bottom of the excavation; at times it came up in volumes as great as 200 gal. a minute. It had a temperature of 50 or 60 deg. and, from the reports of those who tasted it, it was good fresh water. The probabilities are that the water is derived by infiltration from the Potomac River through the gravel bed; although it may have its origin somewhere back in the hills. It was the unusual feature of confinement under pressure that added to the difficulty of driving and concreting piles.

Pile Construction—The specifications provided for the use of either precast or cast-in-place concrete piles, and the contractor selected cast-in-place piles made by driving a thin steel shell to the proper depth and leaving it permanently in place as a form for the concrete. The shells were made in approximately 8-ft. sections, of No. 20, 22 or 24-gauge steel reinforced spirally on 3-in. centers inside with $\frac{3}{8}$-in. wire spot-welded in place at the ends of the sections. The shells were 8 in. in diameter at the point and tapered 0.4 in. per foot. They were fitted over a collapsible steel mandrel and driven by a steam hammer. The dead weight of the hammer and mandrel was approximately 11 tons. The ram weighed $2\frac{1}{2}$ tons and developed energy by a free fall of 3 ft. The spacing of the piles was 30 in., to be maintained within a variable limit of 3 in.

All piles were to be so driven as to develop a bearing value of 30 tons, the penetration on final blow being determined from this value by the *Engineering News* formula, which gave 0.4 in. In the soils encountered it was not always a safe factor for entire control of the penetration, and usually when the additional length was small, in the interest of safety it was exceeded. The length of piles, condition of soil, close proximity to adjacent pits and the variations between friction bearings and point bearing were additional factors to become a part

of the judgment of the inspector in fixing the penetration.

A further reason for the exercise of sound judgment was the unusual character of the soil and the many abrupt changes in elevation of the lower gravel and sand bed. There were instances where piles only 30 in. apart would bring up to final penetration with points 12 ft. apart in elevation. At times piles were driven to refusal to allay a suspicion that the bearing was only on some obstruction of an insecure nature.

Over a part of the site the piles did not reach the gravel, being suspended in the clay by friction. In other parts of the site the piles penetrated the muck and clay by the weight of the hammer equipment alone and brought up after driving but 18 in. farther in gravel, indicating a point-bearing pile.

These variations in soil conditions changed so frequently and abruptly that the inspector's judgment was constantly required to reason out the unknown factors down out of sight, and precaution was always carried a little beyond the specification requirements.

A convenient method of measuring the amount of penetration per blow was to count the number of blows per spiral—8 blows per spiral indicated a bearing value of 30 tons and 12 blows per spiral one of 42½ tons.

Pile Distortion by Lateral Pressure—The usual practice of the pile contractor is to drive a shell and fill it at once. The theory is that the weight of the wet concrete is valuable in maintaining the pile in position and in preventing crushing and collapsing from any underground conditions. This is a theory that has not been subscribed to by the Office of the Supervising Architect for all soil conditions, and I am convinced from my experience with these 21,000 piles that it would not have provided the degree of safety required under the soil conditions here encountered. The specifications contained a clause which reads as follows:

> No shell shall be filled with concrete until after all the adjacent shells within a radius of 5 ft., center to center, have been driven to the required bearing and the shell approved by the construction engineer.

This means that in three-row pile clusters where the centers are 30 in. the concreting follows a minimum of 5 piles behind the driving of the shell to be concreted, with it and all intervening piles open for inspection. In passing it may be said that a mirror reflecting sunlight down the shell is the proper instrument for inspection purposes.

This delay in the concreting enabled the engineers to know what was happening to a driven shell because of the lateral pressure in the soil developed by the driving of the neighboring shells. These destructive effects were so great at times as to establish thoroughly the soundness of the requirement for delay in concreting. There was a large amount of evidence to prove that the lateral pressure developed in the soil conditions here present, i. e. the hardpan overlying the softer subsoil, would be so great as to overcome all resistance of shells filled with wet concrete and destroy the pile without the usual surface evidence of such destruction.

The upper stratum of hardpan and gravel was particularly destructive. Where it was not over 15 in. thick the displaced gravel was absorbed in the soft muck or clay, but where it approached 36 in. thick the pressure set up in the gravel by the displacement was not always dissipated by heave of the soil or absorption by the softer clays, and frequently was relieved by the easier path of crushing or collapsing the adjacent shell.

Occasionally the shell being driven would suffer crushing immediately upon withdrawal of the mandrel. Frequently several piles of a cluster would be in place before any one would crush in and then one or more would collapse. Also the immediately adjacent pile would not always be the one to collapse, the stresses often being transmitted through one or more piles to one farther away before crushing would occur.

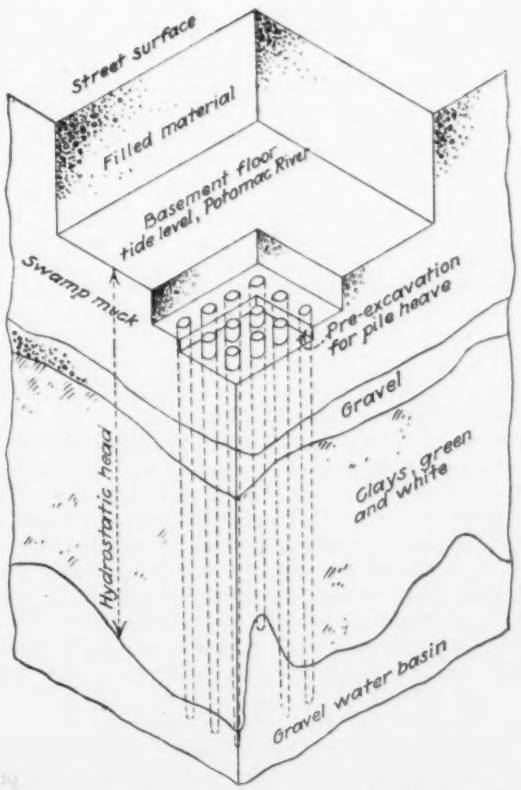


FIG. 3—SKETCH SHOWING SUBSURFACE CONDITIONS AT INTERNAL REVENUE BUILDING

In certain areas of the site where the piles were 30 to 37 ft. long, the destruction was so great as to require a change in the order of driving. Three piles in a row would be placed by driving the intermediate one, inserting a dummy mandrel and driving the two adjacent piles. The next row of piles would be skipped to drive the row 5 ft. away in similar order. The two dummy mandrels would be removed and the six piles filled with concrete. After 48 hours the intermediate rows would be driven.

Occasionally crushing was corrected by dropping the mandrel through the shell, opening it to the original form, and driving an additional section of shell inside the original opposite the point of crushing.

Damage to Pile Casings—The lower bed of gravel and sand furnished another and different cause for damage to pile casings. Shells driven into these gravels would penetrate only a little way and even in the short distance the shell would frequently be cut or torn open at or near the point. With ordinary soil formations probably that tearing open of the casing would in no way injure the pile but here the water under hydrostatic pressure made this damage of such importance that efforts to repair, or better prevent, the damages were an absolute necessity.

As a preventive measure the point of the pile was driven with a double casing, the outside casing being of plain steel as it was less liable to tear and was cheaper.

This method was not always effective in preventing damage to the inner shell. Remedial measures consisted of driving another casing the full length of the pile inside the original casing, care being taken to make certain that the point of the inner casing reached quite to the point of the outer casing and that the two casings were in close contact for the full length. In some of the piles the second, third and even fourth casings were driven before the flow of water was stopped. Inner casings were required to be driven to the same formula for penetration as the original casing. Close contact of the shells was not always obtainable because the flow of water through the torn places carried so much sand or gravel as to fill the lower ends of the original casings for several feet. Whenever an acceptable shell could not be obtained the remedy was to abandon the pile and drive a replacement pile close by.

Effect of Water Flow on Concrete—It was found that excellent concrete poured in a casing that appeared dry and watertight does not always remain concrete, it is transmuted by upflow of water. Pile casings were not concreted until inspection gave assurance that the casings were free from running water—practically dry—and there was reason to believe they would remain watertight against the hydrostatic pressure. However in a number of instances breaks in the casings developed after concrete was poured and the concrete was subsequently destroyed by the water.

It is thought that the casings were just at the breaking point prior to pouring concrete and either the weight of the falling concrete or vibration from close-by pile-driving opened the break. In some instances the break was noticed within a few minutes after pouring, as evidenced by water boiling up through the concrete at the top of the pile and flowing over the top of the casing carrying cement, clay and sand with it. In other instances this action escaped immediate attention and the results were not discovered until the top of the pile was cut off to bring it to the proper elevation to receive the footing.

A study of the action that took place leads to the conclusion that the water forced into the casing near the point converted the plastic concrete to a wet mixture of gravel, sand, cement and clay, and the flow of rising water tended to carry the lighter materials to the top, thus creating a segregation and recombination of the separate materials. The formation at the extreme top of the pile and down for distances varying from 2 in. to 4 ft. was a cement-clay mixture or laitance very fragile and light in weight. Below this there was for varying thicknesses a poor grade of weak cement-sand mortar. There followed a very porous, weak concrete. Below this no exploration was made, but deduction from the evidence in the upper part of the pile leads to the conclusion that the lower part of the pile was composed mostly of gravel and clay.

The only remedy for these defective piles was to drive replacements. A little over ½ per cent of the piles for the Internal Revenue Building were replaced for this cause. A lesson that can be drawn from this experience is to require all piles to be filled to a point at least 3 in. above the cutoff and then cut off to a proper elevation.

Heaving and Weaving of Piles—It is almost an axiom that no pile will stay exactly where you drive it if another pile, is driven alongside or in the immediate vicinity. This is more than ever true where light shells are left unfilled with concrete as was here required. The top will weave back and forth as other piles are driven on either side. This action is as a rule small, but in this soft ground a sidewise movement at the top of the pile of 5 in. has been noted. All piles tended to heave or rise when adjacent or neighboring piles were driven. The effect extended to piles driven as far as the fourth pile away.

The accompanying tabulation illustrates an actual observation of how each successively driven pile affected all preceding piles. It is intersting to note the total amount of heave and the increments of increase for each pile.

HEAVE OF PILES AS INFLUENCED BY ACTION OF DRIVING SUBSEQUENT ADJACENT PILES

Order Driven	Amount of Heave in Inches												
	1	2	3	4	5	6	7	8	9	10	11	12	Total Inches
1	..	3/4	1/2	3/8	1/8	5/16	3/16	1/4	1/8	1/8	...	...	2 3/4
2	..	..	5/8	1/2	3/8	1/2	3/8	1/4	1/8	1/8	1/8	...	2 7/8
3	..	..	..	7/8	1 11/16								
..	..	..	..	..	....	7/16	3/4	3/8	3/8	1/8	1/4	...	4 1/4
4	..	..	..	..	9/16	5/8	1/2	3/4	1/16	1/8	3/16	3/16	3
5	..	..	..	..	....	1/2	1 1/16	....	....	....	....	....	....
..	..	..	..	..	....	....	....	9/16	3/8	5/16	5/16	5/16	3 1/16
6	..	..	..	..	....	....	3/16	1/2	1/4	3/8	1/4	1/4	2 3/16
7	..	..	..	..	....	....	....	9/16	1/2	1/4	3/8	9/16	2 1/4
8	..	..	..	..	....	....	....	....	1 5/16	3/8	0	1/2	1 13/16
9	..	..	..	..	....	....	....	....	....	1 3/8	9/16	3/16	1 7/8
10	..	..	..	..	....	....	....	....	....	....	1/2	3/8	7/8
11	..	..	..	..	....	....	....	....	....	....	....	9/16	9/16
12	..	..	..	..	....	....	....	....	....	....	....	0	0

While this tabulation indicates that the piles heaved for the entire length, there is always present a possibility that the upper section of the pile, especially in piles over 30 ft., may break away from the lower section by reason of this heaving action. Therefore all piles should be reinforced by a ⅝-in. rod anchored top and bottom.

Drainage Helpful—A lesson to be drawn is that a site with these soil and water conditions should be unwatered to the fullest extent possible prior to driving the piles and kept so until all concrete is set. The expense of pumping all the water out of the basins under either of the two buildings would have been prohibitive, but a reasonable expenditure would have reduced the destructive effect of the hydrostatic head. On the Department of Commerce Building the water pressure below the excavation was greatly reduced by pumping from a number of wells sunk for this purpose; in such areas the water levels were reduced so that in many cases the contractor was allowed to drive and fill the steel shells without leaving intermediate shells open.

Cost and Personnel—The cost of the piles for the Internal Revenue job was approximately $1.82 a lineal foot and the cost of the foundation was $82 per pile. For the Department of Commerce Building the cost of piles was approximately $2.00 per lineal foot and $60 per pile for the foundation. In spite of the unusual difficulties encountered, the pile driving was completed within the contract time and is considered satisfactory.

These two buildings form the larger units in the Triangle Development on the south side of Pennsylvania Ave., in Washington now being carried forward under the direction of the Supervising Architect of the Treasury Department.

The writer was in charge of the work and the following associate construction engineers were assistants: C. C. Converse, E. D. Gray, F. A. Roemer, Nels Hansen, F. E. Hayes, Jr., E. S. Grover and J. J. Owens.

The contractor for the foundation of the Internal Revenue Building was the F. W. Mark Construction Company of Philadelphia, Pa. The contractor for the Department of Commerce Building foundation was the Consolidated Engineering Company of Baltimore, Md. For both buildings the piles were driven by the Raymond Concrete Pile Company of New York, N. Y.

Better Curing Raises Core Strengths of Concrete Pavement Base

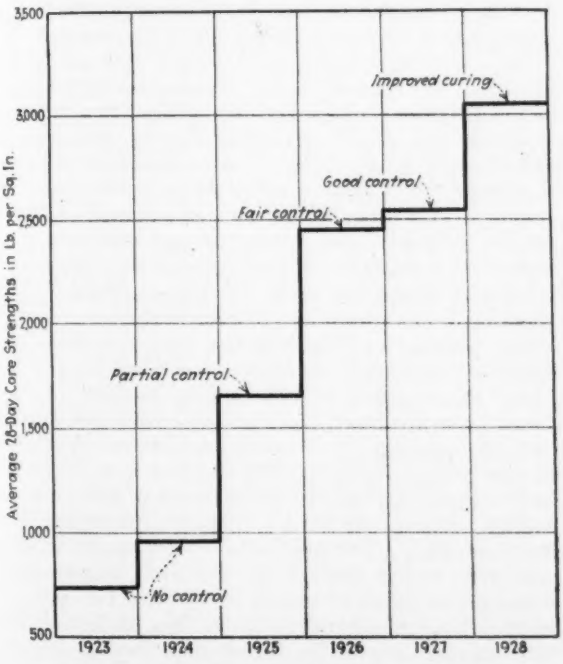
Control and Improved Practice Has Tripled Test Strengths Since 1925 With No Increase in Cost

By M. D. Wilson

Assistant Engineer, Bureau of Highways, Akron, Ohio

THE value of proper curing has been emphasized by the experience of 1928 in laying concrete base for pavements in Akron, Ohio. Indeed the experience of four years since careful control of concrete was commenced in city paving has shown a continual gain in quality and at least no increase if not a decrease in cost.

Work was started in 1925 to improve the quality of the concrete in city work. The first year was one of education for everyone; however, the strength obtained previously was about doubled. In 1926 the results were somewhat near what they should have been. The year 1927 showed a slight increase over 1926, but it was believed that even more improvement could be made. Studies were directed toward various methods of curing and the next improvement was in that process. The specifications had required that the concrete be cured by sprinkling for 10 days after pouring. Considerable trouble was experienced in adequately enforcing this requirement. For 1928 the methods of curing were changed to ponding with water or covering with wet straw. As many streets have rather steep grades the ponding method required too many dikes to be popular with the contractors. Consequently all curing was by covering with wet burlap the first 24 hours and with wet straw for the following 6 days.



YEARLY INCREASE IN STRENGTH OF CONCRETE BASE AT AKRON, OHIO

As a result of this method of curing the average strength climbed from 2,542 lb. per sq.in. at 28 days to 3,056 lb. This is over four times the strength obtained in 1923, the first year for which strength records are had. In addition to the strength increases all concrete cured by 1928 methods was remarkably free from checking and hair cracks. All contractors carried out the various provisions of the curing specifications without urging due to the fact that bids were taken for curing. Previous to this the cost of curing had been included in the price for base.

The low strength of concrete for the no-control period prior to 1925 as shown by the chart obviously calls for some explanation. The figures given are the figures of the records. The engineers who are in charge of the concrete work at present were not in charge at that time, and can only speculate as to the causes of the poor showing in those years. As near as can be determined most of the trouble was caused by dirty material and excess water. In those days material was stock-piled on the street, and probably no two batches were of the same proportions. The inspection of material was not as exacting as at present. Very few mixers had any water control or timing devices, and equipment for testing was rather inadequate. All of these things contributed to the poor showing made by the concrete tested in 1923 and 1924.

In 1929 all concrete for city work will be cured by covering with wet burlap for several days. The specifications have also been revised to permit the use of various types of asphaltic cement emulsions and cutback liquids for curing.

All concrete is tested by means of cores drilled from the completed base or by 6x12-in. cylinders where it is impracticable to take cores. The mix for base has been 1:7½ without allowance for bulking. Next year due allowance for bulking will be made. The accompanying chart will show graphically the progress made.

At the time that the strength was rising the cost of 7-in. concrete base with a 3-in. sheet asphalt top has shown a steady decline from $3.65 per square yard in 1923 to $2.87 per square yard in 1928. While this price is governed by several other factors it does show that the methods followed have worked no great hardships upon either contractors or material men.

Amendments to Public Health Laws in New York State

Among the amendments to the New York State public health laws enacted by the recent session of the legislature and signed by the Governor one permits villages to charge rentals for the use of sewers; one provides for the organization of county health districts in place of general health districts; one provides that municipal health officers must be qualified as required by regulation of the Public Health Council; and a fourth takes out the qualifying word "emergency" from an existing provision of law so without that restriction the state commissioner will hereafter have power to order reasonable measures to be applied for the protection of public health in the case of any water supply "so polluted or subject to dangerous pollution as to constitute a menace to the public health." Any order of the state commissioner of health regarding such water supply must be carried out forthwith by the "municipality, water district or private corporation" which is providing the water supply.

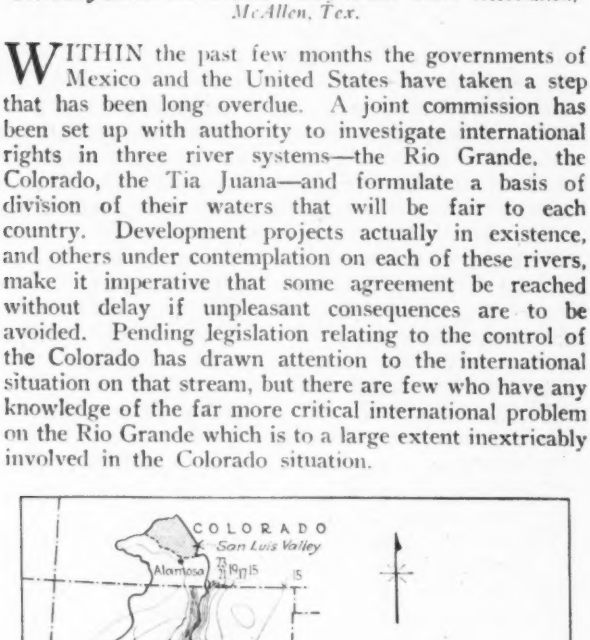
Co-operation Versus Competition for International Water

The United States and Mexico Must Construct Regulating Works on the Rio Grande or Compete for Normal Flow

By C. H. Pease

Secretary Lower Rio Grande Valley Water Users' Association, McAllen, Tex.

WITHIN the past few months the governments of Mexico and the United States have taken a step that has been long overdue. A joint commission has been set up with authority to investigate international rights in three river systems—the Rio Grande, the Colorado, the Tia Juana—and formulate a basis of division of their waters that will be fair to each country. Development projects actually in existence, and others under contemplation on each of these rivers, make it imperative that some agreement be reached without delay if unpleasant consequences are to be avoided. Pending legislation relating to the control of the Colorado has drawn attention to the international situation on that stream, but there are few who have any knowledge of the far more critical international problem on the Rio Grande which is to a large extent inextricably involved in the Colorado situation.



MAP OF RIO GRANDE DRAINAGE BASIN

A clear understanding of these questions requires a brief review of the historical situation. A treaty of peace was concluded with Mexico in 1848, by the terms of which the United States annexed a vast region formerly Mexican territory. Included in this area was a part, but not all, of the drainage basins of the three rivers mentioned. At that time the importance which irrigation and hydro-electric power were to assume in the newly acquired territory was not foreseen. In defining the respective rights of the two countries in the now jointly owned waters, the treaty completely ignored these uses and confined itself to guaranteeing specific rights of navigation, which, in the light of later events, were of comparatively little value to either country.

By thus ignoring irrigation a great injustice was done to a little settlement of Mexican farmers who cultivated their small farms at Juarez. These farmers and their ancestors had irrigated these same lands for at least a hundred years, during which time the entire Rio Grande watershed was under the jurisdiction of Mexico or Spain. Nevertheless, while the treaty left them still in Mexico, it handed over their sole source of water supply to the United States. The upper portion of the Rio Grande was completely severed from Mexico by the new boundary line, which crossed it just above Juarez, and no reservations were made for the protection of the Mexican farmers.

Some 35 years afterward Americans began to occupy the upper portion of the Rio Grande in Colorado and New Mexico. They proceeded to appropriate the water for their own fields and it was not long until the increasing diversions were felt at Juarez. The water supply dwindled and ultimately failed completely. The Mexicans appealed to their government, which in turn sought redress from the United States government. Our Secretary of State called upon Judson Harmon, at that time Attorney General, for an opinion as to the validity of the Mexican claims. Harmon advised that "the case presented is a novel one. Whether the circumstances make it possible or proper to take any action from considerations of comity is a question which does not pertain to this department; but that question should be decided as one of policy only, because the rules, principles and precedents of international law impose no liability or obligation upon the United States." The Mexican farmers were simply out of luck.

The problem was a complicated one. American citizens had acquired vested rights under our laws to Rio Grand water and they could not be divested of these rights, even to restore those of the citizens of Mexico. Still, the equities of the Mexicans were very great. Simple justice demanded that something be done for them; but it took nearly twenty years to work out the solution, during which time their ancient rights were denied to them. Great difficulties were encountered in seeking to find a way to do justice to them without violating the rights of American citizens, but at last a happy solution was found in the building of the Elephant Butte dam by the U. S. Reclamation Service, thereby impounding sufficient storm and flood waters not only to satisfy the demands of the Mexicans but sufficient water in addition to provide for the Texas-New Mexico government project which has reclaimed 155,000 acres additional in these two states.

A new treaty was negotiated whereby Mexico agreed to waive all claims for damages asserted to have been incurred by her citizens through the withholding of water, in consideration of being apportioned, free from all cost, 60,000 acre-ft. per annum. However, a reservation was inserted to the effect that the United States, by entering into this arrangement, did not concede the validity of the Mexican claims and it was stipulated that this settlement was not to be construed as a precedent. No general principle was conceded, and it was further stipulated that the new treaty was to affect only that portion of the Rio Grande between Fort Quitman and

the international boundary. That portion of the Rio Grande below Fort Quitman, therefore, is still left under the provisions of the treaty of Guadalupe Hidalgo.

Even at the time this treaty was signed, events were taking place in the delta region of the Rio Grande that were destined to give rise to other and more serious complications over Rio Grande water. The Rio Grande delta consists of a large area of level land in the vicinity of Brownsville, Tex., and Matamoros, Mexico. The climate is semi-tropical and semi-arid, though healthful and agreeable. The soil is deep aluvium and is very productive when irrigated. The building of a railroad into this region in 1904 was followed by rapid development of irrigation, which was accomplished by the simple expedient of installing pumping plants on the river banks to elevate the water into the main canals, which could then be led in almost any direction, since the slope is away from the river.

Rapid expansion of irrigation development followed and is still taking place on the Texas side; but unsettled political conditions on the Mexican side have prevented the development of lands across the river. Appropriations have continued to increase until at the present time the entire low-water flow is required for the irrigation of some 400,000 acres of land in actual cultivation in Texas, with at least 100,000 acres more under existing projects which have not yet been brought under actual cultivation.

About twenty separate irrigation districts have been formed for taking water from the Rio Grande, besides two private corporations, each operating independently and owning irrigation works. Most of these have heavy outstanding bond issues. Population in the lower Rio Grande is considerably more than 100,000; numerous busy cities and towns have sprung up; two large railway systems have covered the irrigated section with a network of feeder lines; citrus fruits and winter vegetables valued at more than $25,000,000 are shipped annually; and total property values aggregating at least $200,000,000 have been created. All of this is the direct result of irrigation and is dependent upon a continued water supply from the Rio Grande.

With an unregulated flow, irrigation expansion has reached its limit and any corresponding development of irrigation in Mexico must be at the expense of present development in Texas. The physical conditions are favorable to the use of water in Mexico. There are not less than one million acres of marvelously productive land on the south side of the Rio Grande with an easy slope to the east and south. Two decades ago a scheme for irrigating a large area was worked out by a syndicate of wealthy Mexican land owners, but a revolution brought the enterprise to an end. The preliminary engineering was completed, however, and the proposal was nothing less than a scheme to drain the Rio Grande at a point about 25 miles above all the American diversions by tapping the San Juan near its junction with the Rio Grande with a gravity canal cut to the bed of that stream. The San Juan is the lower tributary of the Rio Grande entering from Mexico opposite Rio Grande City. Its bed is below the present silted-up bed of the Rio Grande and a diversion at this point would result in reversing the flow and draining the Rio Grande itself. Such a canal would command an enormous area of land to the west and south of Matamoros and even east to the coast.

That Mexico has important rights in Rio Grande water must be conceded, since two-thirds of the water-

PROPOSED DAM SITE IN MARISCAL CANYON

This canyon, cut by the Rio Grande through the Mariscal range, is located at the extreme southern tip of the Big Bend. At one place the canyon is barely 400 ft. wide. The U. S. Reclamation Service estimated that a dam 200 ft. high would impound 1,400,000 acre-ft. of water.

shed below Elephant Butte dam and the Carlsbad project on the Pecos River lies in Mexico, and approximately the same proportion of the runoff comes from the Mexican side. Three important tributaries—the Conchos, the Salado and the San Juan—lie wholly in Mexico. The Mexican government has under construction and nearing completion a large project designed to control practically the entire flow of the Salado. Other projects are being considered on the Conchos and the San Juan.

Fortunately neither the San Juan nor the Salado are important to the stability of the communities in the lower Rio Grande Valley. Most of their contributions come at times of ample or excessive water in the Rio Grande. However, due to the regulatory effect of the Lago Toronto power dam, the Conchos is the source of a large part of the low-water supply to the American lands and any diminution of the inflow from that tributary will be immediately felt in the lower Rio Grande Valley.

There is no doubt that but for the intervention of the revolution Mexico would have much of the land on the south side under irrigation by this time and the American development would have been limited to a much

smaller area through the exhaustion of the available water supply. The Mexican land can be as conveniently irrigated by the installation of pumps as can the Texas land. With the return of stability to Mexico it is a certainty that she will expect her full equitable share of the resources of the Rio Grande, particularly since the physical conditions permit her to take advantage of those resources without being obliged to secure American co-operation.

Here is a situation that may easily lead to grave international and economic consequences. The enormous interests created in the lower Rio Grande Valley are, under present conditions, exposed to encroachment by Mexico which she could make on plausible legal grounds by merely following the precedent set by this country in the treatment of Mexican citizens at Juarez. Certainly our equities are no greater than those of the Juarez farmers, for our development was made with full knowledge of Mexican rights, while in the other case the water was first put to beneficial use at a time when the United States had no interests involved.

Fortunately there is a way to provide for the just claims of both countries without the necessity of placing any hardship upon individuals or communities now using water. The total annual discharge of the Rio Grande is between 5,000,000 and 6,000,000 acre-ft., while the present consumptive use is probably not more than 1,500,000 acre-ft. There is an ample surplus left to make reasonable provision for a very large additional acreage if the Rio Grande can be adequately regulated. There are known dam sites on the main stream of the Rio Grande at Mariscal canyon in Brewster County, Texas, and another some 35 miles below at Boquillas. Both have ample storage capacity above. The Bureau of Reclamation estimates that a dam at Mariscal 200 ft. high and 400 ft. long would impound 4,400,000 acre-ft. of water. The American section of the International Water Commission under the direction of the chairman, Dr. Elwood Mead, is now investigating other possible sites below, with the co-operation of the Mexican section. Aerial maps have been made of the unsurveyed portions of the main stream covering a strip 5 miles wide on both sides.

There is good reason to believe that there are numerous sites for dams suitable for power development. The drop from Mariscal canyon to the lands to be irrigated is in excess of 2,000 ft., the greater portion of the drop being in canyon region. Some authorities have estimated the possible power development to be as large as 500,000 hp.

Here is an opportunity to develop a great international irrigation and power project which would rank next to the Boulder dam project on the Colorado in magnitude and far-reaching consequences. But unlike Boulder dam, the co-operation of both Mexico and the United States is necessary in order to carry it into execution. Unless these two governments step in and agree upon some basis of division of rights in these waters, there is certain to be a clash of interests.

"It is against all principles of good morals, equity and justice," says Kinney on Irrigation, "that there should be an unregulated scramble between citizens of one nation to appropriate the greatest portion of the waters of international streams to the complete exclusion of the rights in and to those waters of the citizens of the adjoining nation. Each country must concede the rights of the other and its citizens. These rights can and should be determined by careful investigation and should be finally fixed by treaties."

Land Disposal of Activated Sludge at San Marcos, Tex.

Private Owner of Sewerage System Pumps Sludge to Field, Distributes It Through Furrows and Plows In When Dry

By E. G. Eggert and Chester Cohen

Principal Assistant Engineer and District Engineer, respectively, State Department of Health, Austin, Tex.

FINAL disposal of the excess sludge is one of the most expensive and difficult operating problems connected with the activated-sludge process. Suitable treatment of the sludge as it is pumped from the final sedimentation tank may involve sludge thickening, pH adjustment for partial dewatering, filtering and drying.

ACTIVATED SLUDGE DISTRIBUTED THROUGH FURROWS
Sludge is run on the land one day; four days later land is dry enough to be broken up by plow. Sludge-supply pipe in foreground.

Almost any combination of these procedures is too expensive and difficult for the average small activated-sludge plant which is treating 0.25 to 0.75 m.g.d. of sewage. Since preparation of the sludge for use as a fertilizer is usually impracticable, the small plant finally

SLUDGE IN FURROWS DRIED AND READY FOR PLOWING
After one run of the plows under the air-dried sludge more sludge can be applied. No land clogging results, since each new plowing creates a serviceable furrow, while the dried sludge is mechanically incorporateed into the soil, serving as a humus or bulking agent.

resorts to lagooning, but this is being considered more and more as a questionable procedure because of the possibility of odors resulting from the decomposition of partly activated material, nuisances due to fly and mosquito breeding in the damp lagoon and the general

insanitary practice of maintaining considerable areas of stagnant water.

To avoid the difficulties inherent in any proposal for sludge treatment and disposal, the private owners of the sewerage system of San Marcos, Tex., disposed of the sludge on land for a number of years. The plant serves about 6,000 persons and carries an average flow of about 0.35 m.g.d. The excess activated sludge is pumped through an 8-in. cast-iron pipe and distributed on land adjacent to the sewage-works, the lift being 15 ft. Six acres has proved adequate to handle the sludge. It is very probable that less acreage would do in more arid sections or if the land were more intensively worked.

The land is plowed in furrows and the sludge is allowed to flow into successive sets of furrows on successive days. When a set of furrows has been in use for one day it is allowed to dry, after which the surface crust is broken by a single plowing down the center of the furrow and the land is again ready for use.

This method has avoided nuisance and odor, which was especially important, as the plant was located near the center of town and immediately above a swimming resort in the stream receiving the effluent—which is treated with excess chlorine during swimming season. (See "Sewage Treatment in the United States, Report on the Study of Fifteen Representative Sewage-Treatment Plants," U. S. Public Health Service, Public Health Bulletin No. 132, April, 1924, Revision.) The method has furthermore proved relatively inexpensive.

About twenty cities in the semi-arid section of Texas employ broad irrigation for disposal of their city sewage. This involves application of partly settled sewage onto land. The success attended on this simple method of sewage disposal has led to its further adoption as a method of handling sludges.

Record Construction on New Ohio River Bridge

By Ernest E. Howard
Consulting Engineer, Kansas City, Mo.

THE NEW highway toll bridge across the Ohio River at Paducah, Ky., was opened to traffic April 14 after a notable program of rapid construction. Originally delayed by foundation difficulties, actually steel erection was not begun until Sept. 6, about four months late. In spite of winter weather and high water, steel work was completed on Jan. 29, only two months behind schedule. This record is believed to be unprecedented for work in the Ohio River during such a season.

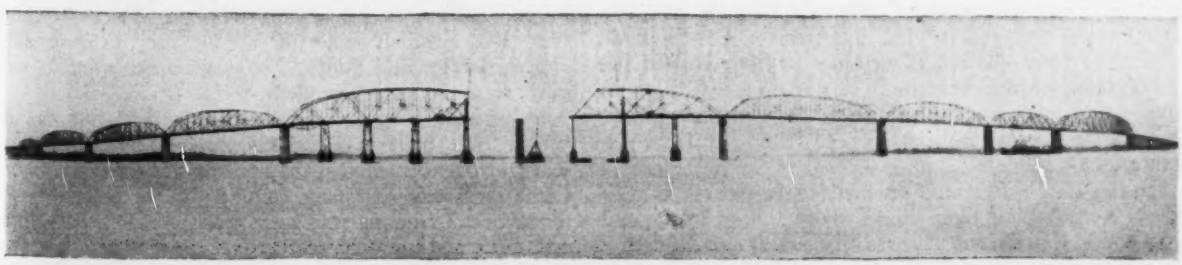
The structure with approaches has a total length of about 9,000 ft. The river at ordinary stages is about 4,000 ft. wide. The main bridge structure across this channel includes seven spans of 396 ft., one of 514 ft. and one of 716 ft. In the accompanying illustration the 514-ft. span is shown under construction at the left. The 716-ft. span is at the extreme right end of the bridge. The trusses are all of the riveted type, in part of carbon and in part of silicon steel. Riveting followed erection closely so there remained only about three weeks of riveting after the last spans were landed.

The spans are about 100 ft. clear above low water. False work consisted of steel bents set on pile clusters. Three bents were used under each 396 ft. span, four bents under the 514 ft. span and six bents under the 715 ft. span. Bents were thus four panels, or approximately 100 ft. apart, and were equipped with jacking wedges for adjustment of camber and for removal. Under the first four panels of each span a temporary erection truss was used; erection to succeeding bents was by cantilevering.

The erection rigs, of which there were four, consisted of single-boom stiff-leg steel derricks supported on tracks laid on the floor beams, and were moved forward as erection progressed. The rig used for the 716 ft. span had a boom length of 135 ft. with a capacity of 21 tons; the other rigs had boom lengths of 115 ft. with rated capacities of 12 tons. All were standard type derricks with jib extensions.

Before the first of December, it was evident spans 9, 10 and 13 (the right hand span in the illustration is span 14) could not be completed before the end of December, the extreme date ordinarily considered safe for work in the Ohio River. Since, however, any cessation of erection would probably delay completion of the bridge about six months, it was decided to proceed with erection of these spans and to utilize specially selected long piles with additional bracing, protected in part with steel against ice erosion. There were numerous delays. On Dec. 24 a raft of some 1,200 logs landed against the falsework of span 9, which was only partly erected, pushed it out of line and temporarily caused grave apprehension for its safety. However, the logs were successfully removed and the falsework repaired. Water and ice conditions also at times made it impossible for the steel barges to be moved and there were days of wind and sleet that made it impossible to work on the high exposed spans. A 40-ft. stage of water was predicted and actually occurred on Jan. 29, but the last span had been successfully landed on the piers on Jan. 26.

The Paducah-Ohio River bridge is the first highway bridge across the Ohio River from its mouth to Louisville, a distance of about 250 miles. It carries a concrete roadway slab 20 ft. wide. The bridge is a result of the enterprise of the Board of Trade of Paducah and of local assistance in financing. The remaining money was



PADUCAH-OHIO RIVER TOLL BRIDGE
Opened on April 14 bridge is first highway structure between Louisville and the mouth of the River.

borrowed on a bond issue through P. W. Chapman & Company. The bridge will be operated as a toll structure. Richard Rudy, president of the Citizens Savings Bank of Paducah, is president of the Bridge Company. Erection work was carried out by the Wisconsin Bridge & Iron Company under the direction of D. K. Allinder, erection manager, with J. W. Marlborough on the job as superintendent. The bridge was designed and construction supervised by Harrington, Howard & Ash, consulting engineers, with Stephen G. Gould as resident engineer.

Emergency Stormwater Pumping Station at Detroit

Temporary Motor-Driven Centrifugal Pump Installed in Suction Well Built for Future Permanent Plant

By Milton F. Wagnitz
Assistant Sewer Engineer, Detroit, Mich.

TO RELIEVE the present inadequate pumping facilities for the removal of stormwaters, the city of Detroit placed in operation last summer an emergency pump in the intake well (Fig. 1) of the future Connors Creek pumping station, which will provide against flooding until this station, now under contract, is completed. The emergency pump will serve the portion of the district lying east of Connors Creek (see Fig. 2). A 14-ft. relief sewer was constructed in Jefferson Ave. in 1927, extending from this intake well east to Alter Road. The relief sewer to the west, in Jefferson Ave., will be built during the progress of the work on the permanent pumping station. From Bewick Ave. to Alter Road the distance along Jefferson Ave. is 12,000 ft.

FIG. 1—STORMWATER PUMPING STATION, DETROIT, MICH.

In the East Jefferson Ave. district the ground is relatively flat, sloping from its northerly limits to a point just south of Jefferson Ave., with a maximum difference in elevation of about 12 ft. The remainder of the area south of Jefferson Ave. is practically at the elevation of high water in the Detroit River. Considerable flooding has been experienced throughout the entire district for several years, but this situation will be relieved upon the completion of the Connors Creek pumping station and the appurtenant sewers, which will be probably in 1930. The relief sewers in Jefferson Ave., and the arms connecting to them, are designed to carry the runoff of about 2,580 sec.-ft. from a storm of ten-year frequency, although the pumping station is planned for an ultimate capacity of 4,000 sec.-ft.

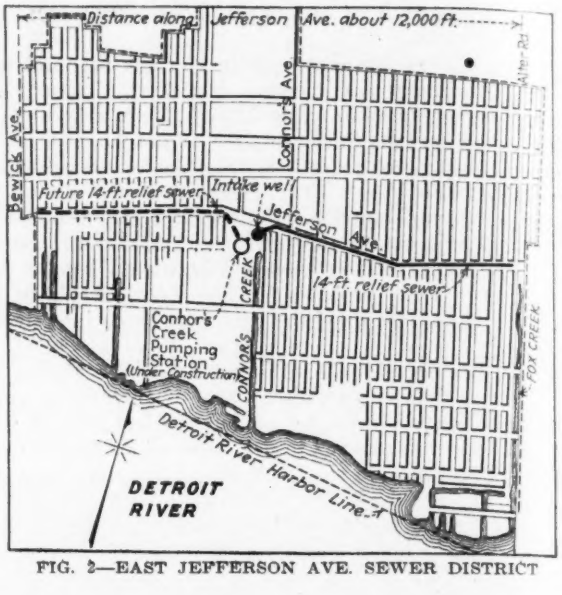


FIG. 2—EAST JEFFERSON AVE. SEWER DISTRICT

The intake well in which the emergency pump is placed is a structure 37 ft. high with an internal diameter of 40 ft. and a depth of 51 ft. below the ground surface. The lower 19 ft. of the entire well comprises the suction chamber. The pump floor is 23 ft. above the suction chamber floor and is designed to withstand the maximum upward pressure which might occur from surge following power failure. Access to the suction chamber is obtained through a shaft extending to the main floor. Underdrainage of the structure is provided by a gravel fill containing a network of tile drains which are connected to a riser pipe within the building, through which the hydrostatic pressure can be measured or relieved. The suction chamber is drained by a small sump pump; the discharge channel is drained by a pipe connection to the suction chamber.

The superstructure consists of a steel frame with columns carrying the roof trusses and the circular runway for a revolving bridge crane of 15 tons capacity. Its exterior is of red brick with stone trim and the interior is faced with pressed buff brick. The walls of the pump-room and switch vault are finished in white enameled brick. All exposed floors are finished with red quarry tile. Red Spanish shale tile is used for the roof, with copper cornice and gutter. A steam-heating plant with oil-burning boiler is installed.

Stormwater flow enters the station through a 14-ft. relief sewer built to serve the district at assumed ultimate development and to be connected eventually to the Connors Creek pumping station. The discharge is through a 7-ft. pipe into a reinforced-concrete channel and thence by a branch to the Connors Creek sewer. A floor plan and section through the station and discharge channel are shown in Fig. 3.

In constructing the pump well, a shovel cut was made over the entire area, approximately 28 ft. deep and 80 ft. across at the top. The remaining depth was trenched and the walls were placed by the segmental method. During the excavation for the walls below the shovel cut, a considerable volume of earth on approximately one-third of the circumference settled some 5 ft., crushing the wall forms which had been set and causing the bottom of the excavation to rise as much as 8 ft. in places. After it occurred, the contractor started the segments on the opposite side of the circle and worked in both directions toward the portion which had moved. When the unstable ground section was reached, the length of the segments was reduced about half, or to about 8 ft., and the work went through without further trouble.

The pumping equipment consists of a 54-in. horizontal-shaft, double-suction centrifugal pump, direct connected to a synchronous motor of 1,000 hp., using 4,600-volt, three-phase, 60-cycle current and running at 277 r.p.m. As the pump operates under a 10- to 19-ft. suction lift, priming is required, and this is effected by a motor-driven vacuum pump capable of priming the pump in two minutes. The centrifugal pump was guaranteed to deliver 250 sec.-ft. at 25 ft. static head, with an over-all efficiency of the pump and motor of 81 per cent. The suction bell extends to within 3 ft. of the floor and is surrounded by a concrete ring to prevent timbers and refuse from entering the pump suction. The station is not provided with racks or screens of any type on the inlet side, the specifications requiring the pump to be tested with sewage which did not pass through racks.

In lieu of the usual definition of "dynamic" head, the head against which the pump was required to perform was defined by the specifications as "the total difference of elevation between the surface of water in the suction well and that in the discharge well when the gate valve is wide open and the flap valve is supported open with its disk in a horizontal position and the pump is in operation." This definition was made in an attempt to avoid the difficulties involved in accurately determining "dynamic" head under the conditions, but placed upon the pump manufacturer the responsibility of estimating all losses between suction and discharge water levels.

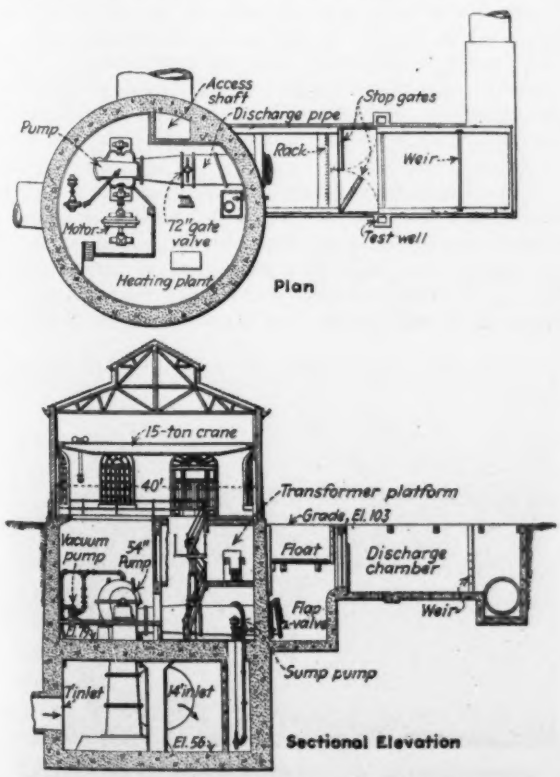


FIG. 3—PUMPING STATION AND SEWER CONNECTIONS

The discharge line is sealed by a 72-in. motor-operated gate valve and an emergency check valve. Provision is made in the discharge channel to test the pump, a stilling rack to straighten out the flow being placed ahead of the weir because of the short distance available in the discharge channel approach. A float covering practically the entire stilling chamber provides for accurately measuring the surface of the discharge water. Suction water elevation is measured by recording gages.

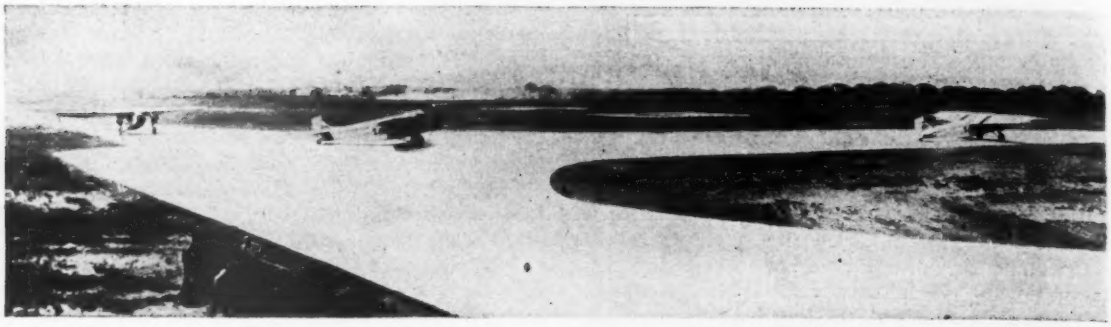
The general building contract was let to the Spencer, White & Prentis Company, Detroit, for $188,000. The electrical work cost $13,800, and the pumping equipment complete cost $34,308, a total of $236,108. The station was designed jointly by the special design department of the city engineer's office, of which the writer has charge, and by Ayres, Lewis, Norris & May, consulting engineers, Ann Arbor, Mich. The design was made under the direction of Perry A. Fellows, city engineer, and John W. Reid, commissioner of public works. Harrison P. Eddy, Gardner S. Williams and Louis E. Ayres acted as consulting engineers.

New First Order Triangulation Arc From Cairo to New Orleans

An arc of first order triangulation is to be run from Cairo to New Orleans in connection with the mapping of the Mississippi Valley as a result of a co-operative agreement reached between Brigadier General Jackson, chairman of the Mississippi River Commission, and the U. S. Coast and Geodetic Survey. The War Department is providing $48,000 toward this work, which will be carried on by Coast and Geodetic technical personnel and equipment Preliminary reconnaissance will start this month. Completion is expected about June, 1930.

The new arc will correct and supplement the existing network of triangulation which follows the river closely. While adequate for local needs, the old stations would not have served for general mapping of large areas contiguous to the river without danger of gaps, overlaps, and offsets which would seriously limit the value of a completed map for engineering purposes. By linking the Mississippi survey with the main triangulation system of the continent, it is pointed out, such errors will be avoided and the standard fifteen-minute quadrangles contemplated by the Corps of Engineers will form an integral part of the topographic map of the United States.

Since the territory to be covered is low and wooded, the instruments will be elevated above the trees by use of steel towers which have been developed for this purpose. These towers are about 110 ft. high and are rapidly erected by bolting collapsible members which are moved from place to place by truck or wagon. Two parties will work on opposite sides of the river. J. S. Bilby, of the Coast and Geodetic Survey, will be in charge of the erection of towers and H. W. Hemple will have charge of the observations. It is expected that a separate part will be organized for making the base line measurements.



Starting End of Concrete Runway at the Ford Airport, Dearborn, Mich.

Designing Concrete Pavement for Airports

Highway Practice Applies But Load Concentrations Are Different—Landing Load Two to Three Times Weight of Plane—The Runway at the Ford Airport

By E. K. Smith

Assistant Manager, Highways and Municipal Bureau, Portland Cement Association, Chicago

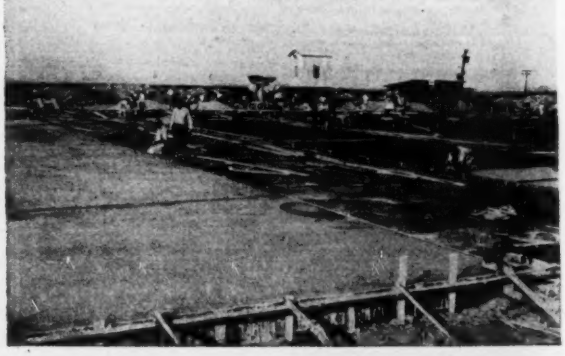
THIS ARTICLE attempts to bring up to date existing knowledge on airplane weights and their use in designing concrete pavements for airports. In addition to incorporating the author's knowledge of the subject, the article has been submitted to Col. H. H. Blee, Chief, Airport Section, Bureau of Aeronautics, United States Department of Commerce, who has read and approved it with some revisions. Information is also included from Stout Air Service, Inc., on the concrete runway at the Ford Airport at Dearborn, Mich. It is therefore believed that the article gives the most complete data yet made available on the subject of concrete pavements for airports.—EDITOR.

THE DESIGN of pavement to serve the needs of an airport presents few problems with which the highway engineer is not already acquainted. The airplane on the ground is much like any other motor vehicle. At the same time, there are points of difference between the airplane and land machines—the concentration of weight on one axle and the use of large tires and special shock absorbing equipment in the landing gear of the airplane for example—which make it necessary to reinforce the use of existing highway design specifications with as complete a knowledge of air transport rolling stock as is possible. Furthermore, the rapid changes in design and the steady increases in weight of airplanes make this knowledge doubly important to the present-day designer of concrete runways and aprons. This article brings this knowledge of aircraft up to date and points out some of the design practices that have been successfully used.

As recently as three years ago, the majority of the planes in use were small and light, weighing from 1,000 to 3,000 lb. With the growth of mail and express contracts came the demand from the commercial air services for larger planes to increase the "pay load" and reduce the overhead. The weight of the commercial planes increased to 3, 4 and 5 tons. The great increase in passenger traffic beginning last year has brought the same result. The 12 to 14-passenger plane weighs with its load 10,000 lb. or more. The same increase in weight is noted in the planes for private or individual use. The best examples of these, such as those on exhibit at the last aero show, all had a weight with load of from 10,000 to 15,000 lb.

Load Assumptions—For the plane at rest on three wheels on a level surface, the front wheels carry about 85 per cent of the load, with only 15 per cent on the tail wheel. A plane with a gross load of 3,000 lb. thus has a static front wheel load of 1,275 lb and a 10,000 pound plane, such as the Ford tri-motor or the Keystone

BUILDING AN AIRPLANE TAXI ROAD AT KANSAS CITY MUNICIPAL AIRPORT



CONSTRUCTING A CONCRETE HANGAR FLOOR AT OAKLAND, CALIF., MUNICIPAL AIRPORT

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GRAND CENTRAL AIR TERMINAL AT LOS ANGELES

Runway is 3,000 ft. long and 92½ ft. wide of which the center strip 72 ft. wide is of concrete flanked by 10 ft. 3 in. asphalt strips on either side. Concrete was poured in three 24-ft. strips with dummy transverse joints every 33 ft. and full expansion joints at 100 ft. intervals. The pavement is unreinforced and 5 in. in thickness at the center increasing to 6 in. at the edges.

or Sikorsky, has a wheel load of 4,250 lb. However, design of runways should be for two-point landing condition, with the entire landing load, including impact, on the front wheels. Twenty- to thirty-passenger planes will undoubtedly be in use in a few years, with gross loads of 20,000 to 30,000 lb. When these larger planes are constructed, however, it is highly probable that the landing gear will be designed with four front wheels with the load equally distributed among them. The impact stresses added to the wheel load while a plane taxis on the field will be slight or negligible. In designing runways it may be assumed that the landing load will vary from about three times the weight of the plane, for planes weighing 5,000 lb., to about twice the weight of the plane, for planes weighing from 20,000 to 30,000 lb.

Design Practice—After determining the weight of the planes to be provided for at any given airport it is a simple matter to design concrete pavement for the appropriate wheel load. Wheel loads of 5,000 to 15,000 lb., are in the same class of loadings common to our highways and streets, and the same method of design will apply. It is generally recognized that concrete pavement will stand indefinitely repeated loadings that do not stress it beyond 50 per cent of its ultimate strength, and infrequent loadings of greater amount. After many tests, notably the Bates Road Test in Illinois and the tests by the U. S. Bureau of Public Roads at Arlington, the following design formula was developed:

$$T = \sqrt{\frac{3W}{M/2}}$$

where T = edge thickness in in.; W = maximum wheel load; and M = modulus of rupture. The thickness in the interior of the slab is to be taken as $0.7T$, and for concrete of good quality today, M will be at least 600.

Pavement on airfields may be divided into three or four classes. On the hangar floor and apron in front,

FORD AIRPORT AT DEARBORN, MICH.

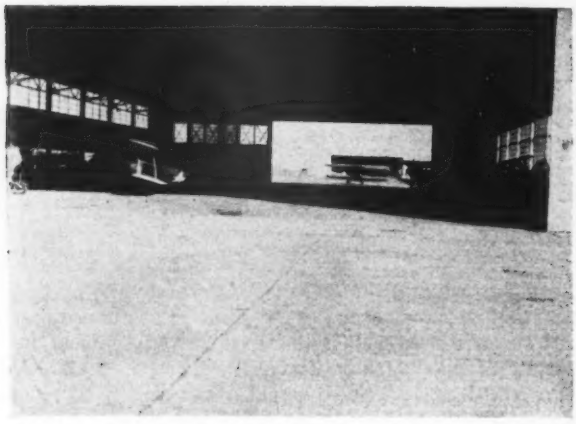
Note position of new runway soon to be built making possible take-off into practically any wind. In the foreground are the factories and hangars of the Stout Air Services, Inc. At the far right of the picture is the passenger terminal and in the center near the end of the runway is the airship mooring mast.

planes and other vehicles move so slowly that no impact is considered. On the smaller fields, a system of taxiways and driveways will carry trucks with supplies, coal building materials, etc. and tank trucks with oil and gasoline. On the most important fields, separate driveways will be provided for all trucking and the taxiways restricted for the use of planes going to and from the hangars. Since a plane will not move at great speed when taxiing on the field, the impact will be less than when landing or taking off. Runways for take-off and

CONCRETE PAVEMENT DESIGN FOR AIRPORTS

Class of Loading For Pavement	Maximum Weight of Plane, Lb.	Probable Number of Wheels	Static Wheel Load, Lb.	Impact, Per Cent	"A" Total Wheel Load Including Impact, Lb. Assumed Usual Maximum	Maximum Load Motor Truck	"B" Maximum Truck Wheel Load Including Impact	Thickness for Slab Load "A" $T = .7\sqrt{\frac{3W}{M/2}}$ Inches	Thickness for Slab Load "B" $T = .7\sqrt{\frac{3W}{M/2}}$ Inches	Recommended Minimum Thickness, Inches Edge	Slab
I.											
Runways	5,000–10,000	2	2,500 to 5,000	200	7,500	.....	.....	6	...	10	6
Taxiways and drives	5,000–10,000	2	2,500 to 5,000	100	7,500	10,000	Impact 100 Per Cent 6,600	6	5.7	8.5	6
Hangar floors and aprons	5,000–10,000	2	2,500 to 5,000	0	5,000	10,000	Impact 0.0 3,300	5	*4	7	*5
II.											
Runways	30,000	4	7,500	100	15,000	.....	.....	8.6	...	12	8.5
Taxiway	30,000	4	7,500	50	11,250	.....	.....	7.4	...	10.5	7.5
Hangar floors and aprons	30,000	4	7,500	0	7,500	20,000	Impact 0.0 6,600	6	5.7	8.5	6
Driveways	.....	..	....	..	.....	20,000	Impact 100 Per Cent 13,000	...	8	11.5	8

*Note: In all localities where the ground may freeze in winter, not less than 6 in. thickness is recommended for any slab construction.
Mix—Approximately 1:2:3½.
Not over 6 gal. water per sack of cement.



CONCRETE HANGAR FLOOR AT OAKLAND, CALIF., MUNICIPAL AIRPORT

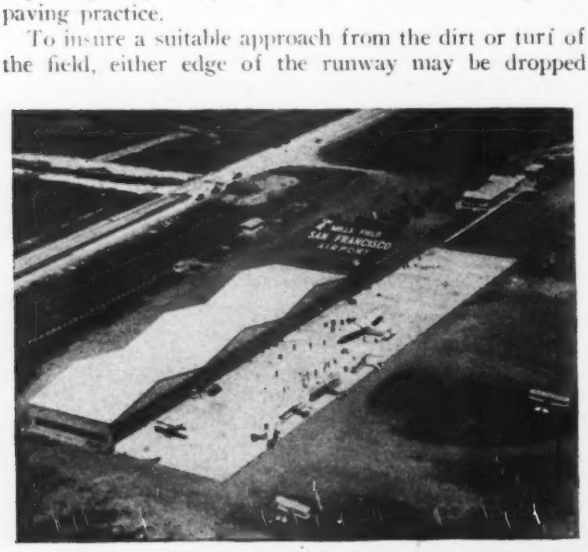
landing will carry planes only, and impacts are of first importance.

Using this classification of pavements, and the above data, the accompanying table has been prepared, showing appropriate designs for concrete pavements. The table is not arbitrary and may be revised whenever conditions arise that alter the loadings on which this table is based.

The matters of mix, reinforcement, etc. are largely affected by local practice and climatic conditions as well as the character of the local sub-soil. Drainage is presupposed, although it must be remembered that where heavy frosts occur, drainage systems do not always function at 100 per cent efficiency.

Runway pavement is today being laid about 75 to 100 ft. wide, with expectation that it can readily be doubled in width if desired. A logical design will provide for laying such pavement in strips 20 or 25 ft. wide, with center joint. This permits economy and uniformity to be gained by the use of a finishing machine (with flat instead of crowned strike-off). Expansion joints should be provided at intervals of not more than 90 ft., with intermediate contraction joints at 30 ft. intervals. The use of bars across center joints and of dowels, free to move, at expansion joints and between adjoining strips of pavement is in line with recognized paving practice.

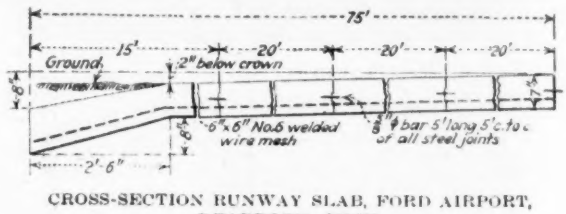
To insure a suitable approach from the dirt or turf of the field, either edge of the runway may be dropped 6 in. in the last 30 in., and the dirt or turf carried over onto it. This will lessen the possibility of a rut forming along the edge of the runway. The best practice seems to be to complete the runway and then build this strip along either edge, connected with tie bars not over four feet apart. In this way a finishing machine can be used on the balance of the runway, and this edge strip can be more easily removed if the runway is widened or otherwise altered.



CONCRETE APRON 100x530 FT. AT MILLS FIELD, SAN FRANCISCO MUNICIPAL AIRPORT

An Example of Good Practice—The first concrete runway to be constructed in the United States was placed in service in 1928 at the Ford Airport, Dearborn, Mich. The completed runway shown on page 835 is 2,653 ft. long and for most of its length 75 ft. wide. At each end of the runway is an area 300 ft. long and 150 ft. wide. The outer area permits planes to turn around on the pavement while the inner area forms an approach to the passenger station.

A cross section of the runway is shown in Fig. 6. The panels are 20x50 ft. made by placing deformed metal



CROSS-SECTION RUNWAY SLAB, FORD AIRPORT, DEARBORN, MICH.

strips parallel to the runway axis at 20-ft. intervals and by installing premoulded expansion joints across the runway at 50 ft. intervals.

The specification for the concrete used read as follows: "Concrete shall be proportioned to give the necessary workability without exceeding a water-cement ratio of 5¼ gallons of water to one sack of cement which is the maximum permissible. The slump shall not be more than one inch." The mix approximated 1 part cement, 2 parts sand and 3½ parts gravel.

The use of a finishing machine was required, the final surface being specified as smooth with no irregularities greater than ¼ in. in 10 ft. Incidentally, only about two-thirds of this runway is concrete, several hundred feet of heavy bituminous macadam being placed in the center in order to obtain a comparison between the two types of construction.

The runway has been a success in every particular. It is reported that pilots did not like concrete at first, believing it too hard and preferring ordinary turf. However, W. B. Stout, president, Stout Air Service, Inc., recently stated that pilots had soon come to appreciate not only the taking off possibilities but also the landing possibilities of a hard surfaced runway.

Army Engineers to Study Beach Erosion

More precise and accurate information on the subject of sand movement and beach erosion will be sought by a special committee of army engineers appointed by Maj. Gen. Edgar Jadwin, chief of engineers. This board consists of Col. William J. Barden, division engineer at New York; Col. George B. Pillsbury, district engineer at Philadelphia; Col. Elliott J. Dent, and Maj. Brehon Somervell, district engineer for the Washington area. Work will be carried on in the Rockway Point, N. Y., Cape May, N. J., and Pensacola, Fla., areas.

Analysis of a Building Concreting Plant

Eight Plants Estimated on Basis of Materials Cost at Mixer and Selected Plant Analyzed for Deficiencies at Job's End

By John G. Ahlers

Barney-Ahlers Construction Corporation, New York, N. Y.

This Plant Study exemplifies excellently the thought being devoted in modern construction to the engineering of the field plant under the best contractors. The plant is a studied selection from all possible plant arrangements reduced to a common basis for comparison. Even in building construction, where plant-investment figures are small compared with those on general engineering construction, the equipment expenditure runs quickly into the scores of thousands, and careful plant analysis therefore pays dividends.

—Editor.

DETAILED estimates for eight possible plant installations were made in planning the construction of the new Lehigh Valley Railroad warehouse at 144th St. and Girard Ave., in New York City. This variety of choice was made possible by the location of the work only 500 ft. from the river, making delivery of materials possible by boat or railway or truck haulage (Fig. 1.) The accompanying table shows the plant types worked out and the estimated cost of each item for each type. As will be seen, all costs were reduced to a common basis for comparison.

General Requirements

Concrete of specified strength at 28 days had to be produced. It was therefore imperative that a plant assuring accurate water-ratio control methods and both volume and weight batches should be used. It was also necessary that the plant be large enough and so located that the concrete could be poured at the rate of one floor a week. In considering all types of plant it was decided that:

1. The plant would be placed on the west side of the building, where the railroad sidings are located and where the most storage space is available. On the north and east the building faces on public thoroughfares, which are less suitable.

2. The practice followed on other jobs by this company would be repeated here; this is to place the plant nearer to that end of the building at which form erection is started so that steel and concrete work can follow soon after.

Eight Plants Compared

The basis of comparison decided on was the total of plant-installation and labor costs for materials delivery to the job reduced to a cubic yard unit. By this comparison of the cost of the materials as delivered to the concrete mixer there was obtained a definite indicator of the most successful plant installation. The following were briefly the reasons for and objections to each type of plant:

1. *Delivery by Batch Trucks*—This installation would give the minimum amount of plant. A truck would back up to the mixer and unload a batch of aggregate directly into the mixer. This would eliminate all ramps at the building, but it had the objection of possibly delaying the mixing operation, uncertainty of measurements, difficulty

COMPARISON OF PLANT INSTALLATION COSTS, LEHIGH VALLEY WAREHOUSE

	1	2	3	4	5	6	7	8
						Central Mixing Plants		
	Batch Trucks	Kopped Cars and Engine	Ramp Outside Delivery	Aggregate on Belt Conveyor	Barney-Ahlers Truck on Ramp	Trucking 2-Yd. Trucks	Chuting	Belt Conveyor
Bulkhead work	100	100	.....	100	100	100	100	100
Cross over	100	100	.....	.....	100	.....	.....	.....
Derrick setup—Derrick takedown	500	500	.....	500	500	500	500	500
Sixteen-week rental	1,600	1,600	.....	1,600	1,600	1,600	1,600	1,600
Sixteen-week repair	500	500	.....	500	500	500	500	500
Engineers	1,600	1,600	.....	1,600	1,600	1,600	1,600	1,600
Two laborers—Cleaning up	1,600	1,600	.....	1,600	1,600	1,600	1,600	1,600
Fireman	700	700	.....	700	700	700	700	700
Coal and water	1,500	2,200	.....	1,500	1,500	1,500	1,500	1,500
Unloading bins	500	500	.....	500	500	1,000	500	1,000
Tunnel	.....	.....	.....	300	.....	.....	.....	300
Extra laborer	.....	.....	.....	500	.....	.....	.....	500
Belt conveyor	.....	.....	.....	5,500	.....	.....	.....	5,500
Rental, engine and fifteen cars	.....	1,800	.....	.....	.....	.....	.....	.....
Maintenance	.....	500	.....	500	.....	.....	500	.....
Additional three laborers	.....	2,000	.....	.....	.....	.....	2,000	.....
Installing and dismantling	.....	500 including grading, etc.	.....	.....	.....	.....	3,500	.....
Engineers	.....	1,300	.....	800 extra time	.....	.....	1,600	800
Power	.....	.....	.....	200	.....	.....	200	200
Mixer bins	.....	1,000 Inc. ramp	1,000 Inc. ramp	500	1,000 Inc. ramp	.....	.....	100
Water lines	100	100	.....	.....	.....	.....	.....	.....
Weighing hoppers	200	200	200	200	200	200	100	200
Mixer pits, extra	.....	200	.....	.....	.....	.....	200	.....
Tower pits	.....	.....	.....	.....	.....	.....	200	.....
Dismantling	Inc.	Inc.	.....	Inc.	.....	.....	Inc.	.....
Salvage	.....	.....	.....	2,000 Conveyor	11,000	.....	.....	2,000
Truck cost	.....	.....	.....	.....	15,000	.....	.....	.....
Truck rental	6,500	.....	.....	.....	.....	6,000	.....	.....
Higher cement factor	.....	.....	.....	.....	.....	.....	250	.....
Drivers	.....	.....	.....	.....	2,400	2,880	.....	.....
Total	15,500	17,000	1,200	15,100	16,300	18,180	17,150	14,700
At 19,000 yd.= per yd	0.82	0.89	0.06	0.79	0.86	0.96	0.90	0.77
Cost alongside, s.y	2.00	2.00	On job 2.70	2.00	2.00	2.00	2.00	2.00
Cost at mixer	2.82	2.89	2.76	2.79	2.86	2.96	2.90	2.77

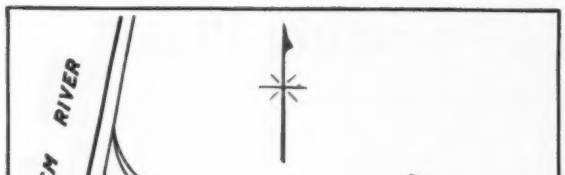


FIG. 1—LOCATION PLAN AND POSSIBLE PLANT LAYOUTS

in bad weather, eliminating reserve storage at the building and no exact control of the aggregate.

2. *Industrial-Railway Cars With Engine — This* arrangement would involve the installation of a stiff-leg derrick at the waterfront with a clamshell unloading to trucks; at the building the trucks would have to be hauled by small engines up over bins. As noted from the layout, Fig. 1, such trucks would interfere with the unloading of reinforcing steel and lumber from the only available siding at the building. Ground would have to be rented adjacent to the operation, and this could not be obtained on any long lease. There would be a possible loss of time for shunting cars, and in case of a breakdown of the engine there would be small reserve at the building.

3. *Ramp to Bin With Outside Delivery*—This plan was the most economical in cost of installation and was the one finally adopted, as the cost per yard of material delivered by an outside contractor was less than the cost delivered alongside plus the cost of unloading by any of the other schemes. The objections were that the ramp might interfere with hoisting steel and forms at the building. This actually turned out to be the case, but the difficulty was overcome by putting a longer boom on the tower.

4. *Belt Conveyor*—This plan involved the installation, as in plans 1 and 2, of a stiff-leg derrick unloading plant at the dock transferring materials to a belt conveyor which would bring them to bins over the mixers. The cost of this installation was comparable to the first two. The objections were possible breakdown of the conveyor, the risk of not obtaining a large salvage at the conclusion of the operation, lack of space for the installation of the belt conveyor and interference with unloading of steel and other material from the railroad siding.

5. *Contractor Using Own Trucks to Ramp From Waterfront*—This was the most expensive of all the proposed installations. It would also take a great deal of the superintendent's time away from the actual building operation. A large investment for trucks would be required with uncertainty of ultimate salvage. Other uncertain items were garage rental, and repairs.

6. *Central Mixing Plant at Waterfront, Moving Concrete in 2-Yd. Trucks*—This installation proved prohibitive in cost, as shown by the table. It was also considered that there would be difficulty in regulating the consistency and the slump of the concrete and that there would be too much labor involved in pouring small units in the cleaning-up operations.

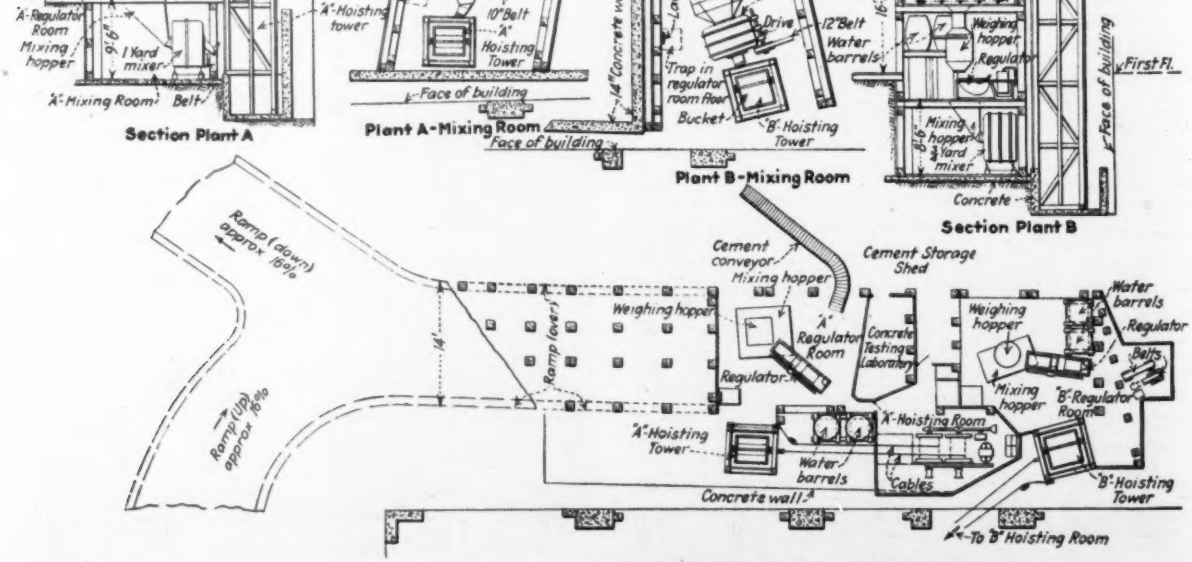


FIG. 2—ADOPTED CONCRETE PLANT FOR LEHIGH VALLEY WAREHOUSE

7. *Central Mixing Plant Using Chutes*—The objection to this plan was that it would involve very high towers, this in turn demanding many guy lines interfering with the installation of the structural steel cores and necessitating permits from adjacent property owners. It would also involve the employment of high-priced riggers and ironworkers and the uncertainty of long chutes. The concrete, too, would have to be too wet.

8. *Central Mixing Plant With a Belt Conveyor*—This arrangement showed a low cost as compared with plans 1 and 2, but it had the same objections of installation and of breaks which might cause accumulation of concrete and lead to large wastage. It also interfered with unloading steel and other material. In all of the central mixing plants the superintendent also felt that the control of the pulse of the job would be too far away for efficient handling of the concrete in the structure.

Faults of Adopted Plant

The plant determined upon is shown in Fig. 2. This is plan 3 and involves delivery by an outside organization over a ramp to bins built over the mixers. This plant is now working efficiently; only one or two improvements could be made—namely:

1. The location of the larger mixing plant should have been one bay farther north. The 1-yd. mixer has proved so efficient and capable of turning out yardage that the secondary or stand-by plant is being used mostly for follow-up work such as curtain walls, sills, etc.

2. The bin and ramp should have been built sufficiently strong to take 10-ton trucks, as these are now becoming standard for delivery of aggregate in New York City. The ramp and bins had to be reinforced to take the 10-ton trucks.

3. Difficulty was experienced in the beginning of checking the truckloads for full delivery, as the material dealer was using some batcher trucks which were difficult to measure. This difficulty was overcome by weighing the trucks.

Conclusions

1. It will be found advantageous to contractors to use the facilities and organization of materials people for unloading and delivering aggregates. A contractor cannot do the work as economically as a firm making this work its business.

2. The simplest plant is the most economical in the end, and it is better for a contractor to concentrate on his construction work and let outside firms take the burden of delivery of material properly and on time.

3. Salvage on large plant installations is so small as to render the cost of such installations prohibitive.

Study of Intensive Rainfall in Four Nebraska Cities

Precipitation Records of 457 Storms from 1896 to 1928 Analyzed and Diagrammed to Aid in Sewer Design

By F. M. Veatch

Of Black and Veatch, Consulting Engineers, Kansas City, Mo.

INTENSIVE rainfall records at four Nebraska stations are analyzed in this article, with the view of putting the recorded data in such shape that they can be used in the design of storm sewers by the rational method. The records, which were worked up for use in designing storm sewers for Grand Island, Neb., are those of the U. S. Weather Bureau at Lincoln, Omaha, Valentine and North Platte:

	Number of Storms	Period	Years
Lincoln	164	1896-1928	33
Omaha	151	1897-1928	32
Valentine	78	1901-1928	28
North Platte	64	1907-1928	22
	457		

The records as kept by the observers have been rearranged to show the maximum rates of precipitation for various periods of time, and the 30 most intense rates, for each station, have been plotted (Fig. 1) in order of magnitude and without regard for the occurrence of the storm—that is, the maximum rates recorded may or may not have occurred in the same year or in the same storm. The rates as plotted in Fig. 1 therefore represent intensities which will probably occur once, twice, three times, etc., during a period equal to that of the record, and only the 30 most intense rates have

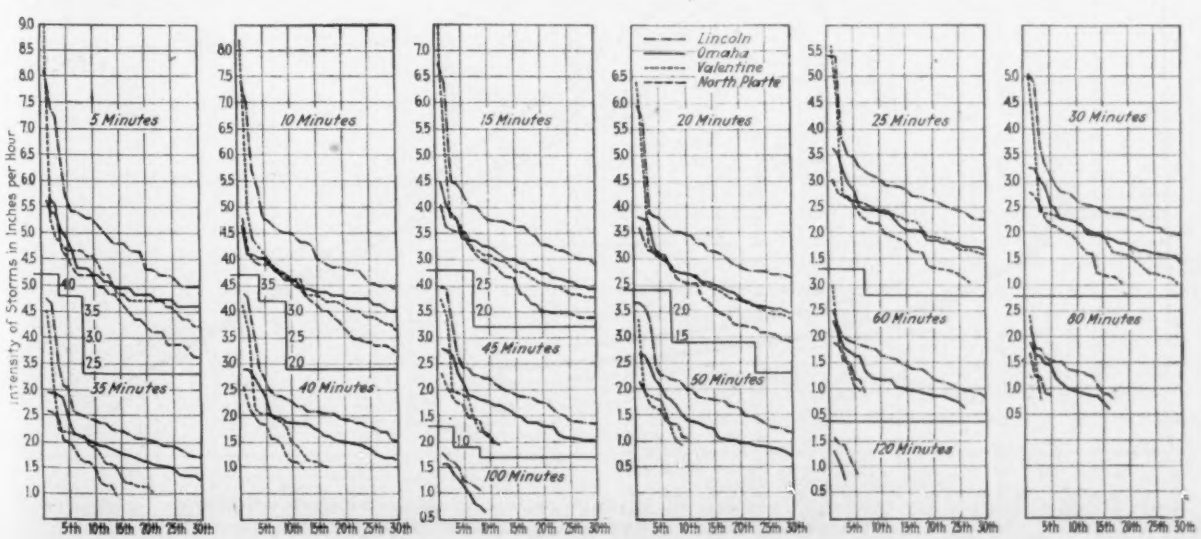


FIG. 1—THIRTY MOST INTENSE RAINS AT FOUR NEBRASKA STATIONS, 1896-1928, IN ORDER OF MAGNITUDE

been plotted, since this brings the record down approximately to that of storms which may be expected at yearly intervals.

The probable interval between storms of various intensities and for durations of 15, 30 and 60 minutes is shown in Fig. 3 in so far as the available data permit.

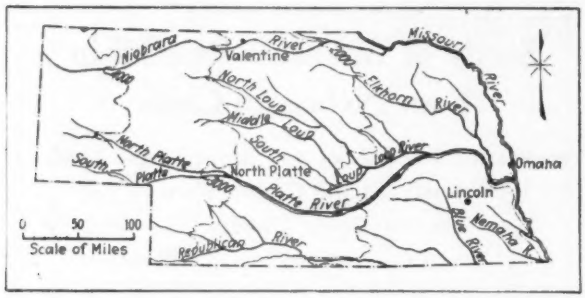


FIG. 2—FOUR NEBRASKA RAIN GAGE STATIONS

These curves give a relatively good idea of the frequency of storms of various intensities at the different stations, although their accuracy would be much greater were the record for a greater number of years available for inclusion in the calculations.

A formula for rainfall intensity may be obtained by plotting the expected intensity as ordinates and the duration as abcissas on logarithmic cross-section paper. The graphs in Fig. 5 represent storms which will probably be exceeded once in five years and are plotted from the curves of Fig. 2 by excluding six storms at Lincoln and Omaha, five storms at Valentine and four storms at North Platte.

In view of the fact that the design of storm sewers rarely calls for an "inlet time" of less than fifteen minutes and since the records of excessive storms of greater duration than 60 minutes is very meager, the graphs in Fig. 5 have been made with special attention to storms which have lasted from 20 to 50 minutes. The formulas derived from these graphs will therefore give values higher than the record indicates for storms outside these limits.

A formula of the general type $I = \frac{K}{t^n}$ (in which I = intensity of rainfall in inches per hour, t = duration of storm in minutes, K = constant), may be derived graphically from these graphs since, as plotted in Fig. 4, the slope of the graph is the exponent n, and the ordinate for $t = 1$ is the constant.

The formulas for intensities of five-year storms at the four stations are therefore: Lincoln, $I = \frac{20}{t^{0.57}}$; Omaha, $I = \frac{14.3}{t^{0.54}}$; Valentine, $I = \frac{15.2}{t^{0.55}}$; North Platte, $I = \frac{24.2}{t^{0.70}}$.

The use of a formula for intensity in the rational method is very tedious and a curve is sufficiently accurate, but for convenience this curve should be plotted on common co-ordinate paper as shown in Fig. 4.

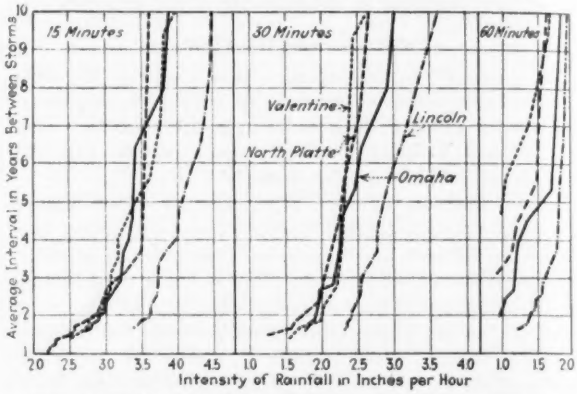
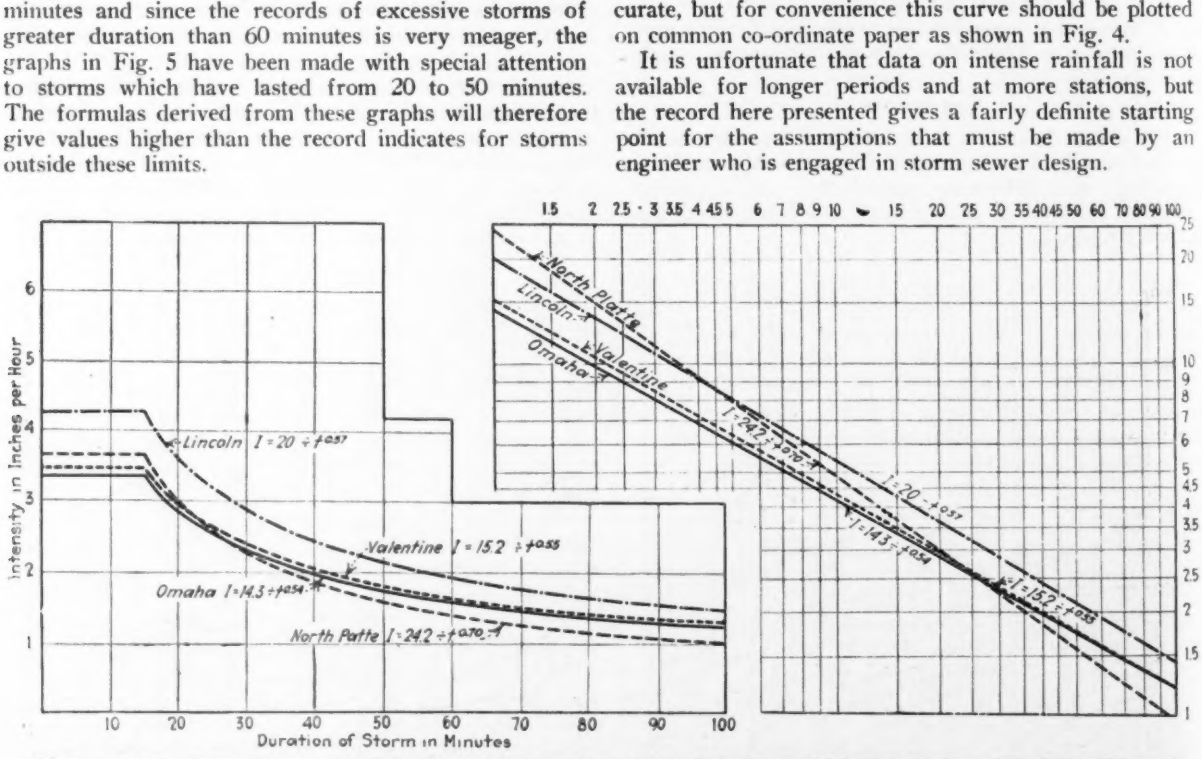


FIG. 3—PROBABLE YEARS BETWEEN 15-, 30- AND 60-MINUTE STORMS OF VARIOUS INTENSITIES AT FOUR NEBRASKA POINTS

It is unfortunate that data on intense rainfall is not available for longer periods and at more stations, but the record here presented gives a fairly definite starting point for the assumptions that must be made by an engineer who is engaged in storm sewer design.


Intensity in Inches per Hour
Duration of Storm in Minutes
Lincoln I = 20 ÷ t0.57
Valentine I = 15.2 ÷ t0.55
Omaha I = 14.3 ÷ t0.54
North Platte I = 24.2 ÷ t0.70
North Platte
Lincoln
Valentine
Omaha

FIGS. 4 AND 5—RELATIONS BETWEEN INTENSITIES AND DURATIONS OF STORMS WHICH MAY BE EXPECTED AT FIVE-YEAR INTERVALS IN FOUR NEBRASKA TOWNS

All curves give intensities higher than the record indicates for storms under 15 and over 60 minutes' duration.

Control of Washing at Rapid Water Filtration Plants

Studies at Baltimore Indicate Vertical Velocity Rate of 2.7 Instead of Usual Rate of 2 Ft. Per Minute

By Edward S. Hopkins

Principal Sanitary Chemist, Montebello Filters, Bureau of Water Supply, Baltimore, Md.

SERIOUS clogging of sand filter beds in different parts of the country has given rise to an opinion among many plant operators that the accepted standard wash of 2 ft. vertical rise per minute is not sufficient to keep the beds in proper condition. In view of this a study was undertaken to learn, if possible, some relation between washing characteristics and maintenance of clean beds with subsequent long periods of operating service. It was assumed that clean beds would minimize the possibility of mud ball clogging.

When washing filters it is the usual practice to utilize the clarity of the final wash water as the criterion of the cleanliness of the bed, this clarity being determined solely by casual inspection of the operator as the water passes into the drain troughs. Testing seven experienced filter operators, it was found that the turbidity of such wash water varied from 25 to 150 p.p.m., depending upon individual reactions and light conditions. Since it is logical to expect the period of filter operating service (filter runs) to be more or less controlled by the cleanliness of the bed, therefore the cleaner the bed the longer the filter runs, other conditions being equal, due to a minimum initial mud load. This assumption is confirmed by a study of the curves in Fig. 1. Using a constant filtration rate (125 m.g.d. per acre) with the applied water properly coagulated, having a turbidity between 4 and 7 p.p.m., it appears that a minimum final wash-water turbidity gives a maximum period of operation.

These curves also indicate that the velocity of wash water is a factor in obtaining clean beds. When washing with a velocity of 2.9 ft. vertical rise per minute it will be noted that with a one-minute wash and final wash-water turbidity of 800 p.p.m. it was possible to obtain a filter run of 50 hours. Using a velocity of 2.3 ft. vertical rise, giving a turbidity of 400 p.p.m. for a similar period, a run of only 35 hours was obtained. Further inspection of these curves shows that the filter runs are practically constant for a final wash-water turbidity of 75 p.p.m., thereby indicating that the bed is clean, with this condition existing for all velocities of wash water applied. Any increase in filter operating time greater than indicated is due to the characteristics of the applied water rather than to washing conditions. These results confirm the belief that filters should be washed with the highest velocity comparable to plant design.

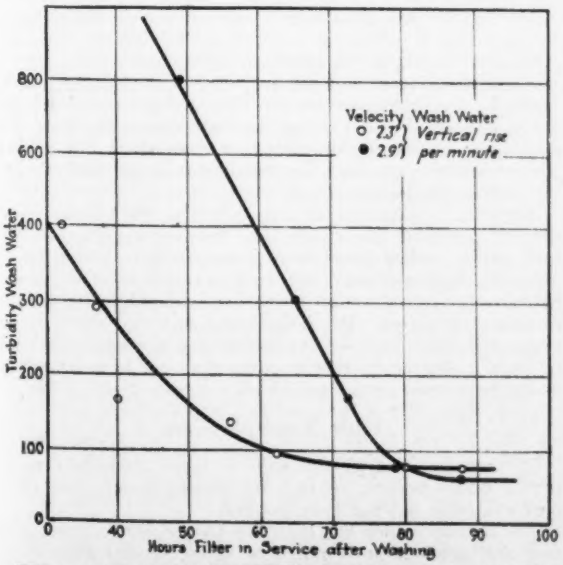


FIG. 1—RELATION BETWEEN TURBIDITY OF WASH WATER AND FILTER RUNS

Since it is not practicable as routine procedure to make turbidity determinations of the wash water during the restricted washing period, a simpler control method must be utilized. Such a control can be easily maintained by regulating the time of wash in relation to the velocity of wash water applied. Inspection of the curves shown by Fig. 2 shows that the maximum cleanliness of bed (75 p.p.m. final wash-water turbidity) does not require prolonged washing. Filters washed in accordance with these curves would be in this ratio: 2.3 ft. vertical rise per minute requires a six-minute wash, 2.7 ft. vertical rise per minute requires a four-minute wash, 2.9 ft. vertical rise per minute requires a four-minute wash.

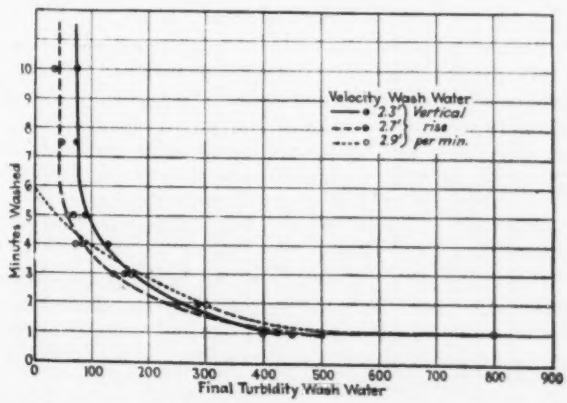


FIG. 2—RELATION BETWEEN TIME WASHED AND FINAL TURBIDITY OF WASH WATER

A four-minute wash of 2.7 ft. vertical rise is therefore the most economical rate. It gives an easily controlled cleanliness of bed with assurance that the maximum filter runs are being obtained. These results would indicate that the present accepted standard of 2 ft. vertical rise is inefficient and if plant design will permit the use of these higher velocities, without loss of sand, increased filter runs will be obtained.

It is believed that this study has a definite practical value as the information was obtained from a filter unit operating under normal conditions. It is realized that these conclusions may not strictly apply elsewhere, due to various characteristics of plant design, but should prove to be an excellent guide for use in operation.

For descriptions of the earlier of the two filtration plants at Baltimore see articles by James W. Armstrong, filtration engineer, Baltimore Water-Works, in *Engineering Record*, Vol. 69, p. 520 (1914); *Municipal and County Engineering*, Vol. 61, p. 234 (1921); *Journal* N.E.W.W.Assoc., Vol. 39, p. 254 (1924).

Factors of Prosperity

A Searching Report Into Recent Economic Changes Which Have Occurred in the United States

A STRIKING picture of the factors involved in the country's steadily maintained prosperity since 1922 is presented in a brief report just issued by the Department of Commerce under the title "Recent Economic Changes in the United States." The report is the work of a committee of the Department, headed by President Hoover, and represents one of three studies which grew out of the presidential conference on unemployment in 1921. The two preceding studies dealt with business cycles and unemployment (1923), and seasonal operation in the construction industries (1924).

An elaborate compilation of data and analyses of separate factors (living standards, finance, technological progress of industry, and others) was made for the committee by the National Bureau of Economic Research. This underlying survey is being published as a two-volume work under the same title as the pamphlet, about to be brought out by private publishers for the committee. The brief report of the committee, however, summarizes its findings.

Beginning with an outline of the business conditions prevailing since 1922, the report discusses successively the influence of power, credit, price and wage relations, growth of production and consumption, and the economic balance. Some representative extracts follow:

Progress Exceptionally Rapid

Acceleration rather than structural change is the key to an understanding of our recent economic developments. The changes have not been in structure but in speed and spread.

While the period from 1922 to 1929 has been one of intense activity, the committee noted that this activity has been "spotty." Certain groups have been more active than other groups. Geographical differences also were noted. The Pacific States have made an extraordinary advance; the South has rapidly developed as a manufacturing area; the East North-Central Division has grown; while the New England States, and to some extent the Middle Atlantic section, have developed less rapidly.

However, the rising standard of living characteristic of this period was widespread and has reached the highest level in our national history. Participation by the people as a whole in many of the benefits of increased productivity, which of itself varied as between different groups and geographical areas, has been one of the marked characteristics of the period.

Power and Credit Ample

Characteristic also has been the rise in the use of power—three and three-quarters times faster than the growth in population. Factories no longer need cluster about the sources of power. The increasing flexibility with which electricity can be delivered for power has enabled manufacturers and farmers to meet high labor costs by the application of power-driven specialized machines. Through the subdivision of power the unskilled worker has become a skilled operator.

This acceleration of forces and its resultant rising standard of living have been facilitated by a continuing supply of funds. For the larger part of this period not only the earnings and savings of the people supplied the additional capital for financing the rapid development of industry, but in addition they furnished several billions of dollars for loans to foreign countries. The number of shareholders in the country's business enterprises has, it is estimated, grown from about two million to more than seventeen million. Meanwhile industry has been able to reduce its requirements for short-term credits from the banks through issuance of securities.

Wages Ahead of Prices

In the field of price relationships, wages, and the cost of living is to be found one of the striking and significant developments revealed by the survey, and one which more than any other gives these years their distinctive character. Between 1896 and 1913, the wholesale price level rose on the average 2.3 per cent a year, but wages rose only a little more, so that their purchasing power advanced only 0.5 per cent a year. In the period from 1922 to 1927, prices declined on the average 0.1 per cent per year, while the purchasing power of wages rose 2.1 per cent a year.

Price fluctuations seem to have been held within narrow limits during this period by a combination of factors: A more complete background of statistical information making possible better judgment regarding supply and demand on the part both of producers and consumers, prudence on the part of management, cost reductions by technicians, skill on the part of bankers, an enlightened attitude on the part of labor, and the expansion of foreign markets.

With rising wages and relatively stable prices we have become consumers of what we produce to an extent never before realized. The factors in this situation appear in part to be accidental and in part the consequences of an advanced economic point of view.

Production and Consumption Steadily Increased

Since 1922 primary production has been increasing 2.5 per cent a year; manufacturing, 4 per cent a year; transportation, 4 per cent. Taking 1919—a year of fair harvests—as a base, crop production in 1922 was 102; in 1925, 104; in 1927, 106.

There have been prosperous periods in the past which may have surpassed these rates of increase, but none so far as the committee can learn which has shown such a striking increase in productivity per man-hour. Notwithstanding the reductions in hours of labor, per capita productivity is nearly 60 per cent greater than it was toward the close of the nineteenth century; the increase in per capita productivity in manufacturing from 1922 to 1925 was 35 per cent; the productivity of farm workers has increased at a rate probably never before equaled.

As a people we have become steadily less concerned about the primary needs—food, clothing, and shelter. Our wants have ranged more widely and we now demand a broad list of goods and services which come under the category of "optional purchases."

Increased Leisure Time

During the period covered by the survey the trend toward increased leisure received a considerable impetus. The work week was shortened in the factory by better planning and modern machinery, and the workday was shortened in the home by the increased use of time-and-labor-saving appliances and services. Few of the current economic developments have made such widespread changes in our national life or promise so much for the future as the utilization of our increasing leisure.

Few of the developments revealed by the survey are of greater potential significance than the accelerated growth of our service industries—travel, entertainment, education, insurance, communication; the facilities of hotels, restaurants, delicatessen stores, steam laundries, and public libraries, to mention but a few. We have integrated these services and organized them, and we have developed the new philosophy to such a degree in recent years that we now have what might be termed "mass services."

Little Unemployment

No serious cyclical fluctuations have characterized the period under review, so that the unemployment due to the business cycle has not been marked.

The balance which has been maintained between consumption and production is nowhere better shown than in the fact that wages have been rising, and that there has been

no striking increase of unemployment in a period marked by the broadest technological advancement which we have yet known.

The Future

The survey has proved conclusively what has long been held theoretically to be true, that wants are almost insatiable; that one want satisfied makes way for another. The conclusion is that economically we have a boundless field before us; that there are new wants which will make way endlessly for newer wants, as fast as they are satisfied. We seem only to have touched the fringe of our potentialities.

We cannot maintain our economic advantages, or hope fully to realize on our economic future, unless we conciously accept the principal of equilibrium and apply it skillfully in every economic relation. To maintain the dynamic equilibrium of recent years is, indeed, a problem of leadership which more and more demands deliberate public attention and control. Research and study, the orderly classification of knowledge, joined to increasing skill, well may make complete control of the economic system a possibility.

Once an intermittent starting and stopping of production-consumption was characteristic of the economic situation. It was jerky and unpredictable, and overproduction was followed by a pause for consumption to catch up. With greater knowledge of consuming habits, with more accurate records of the goods consumed, a sensitive contact has been established between the factors of production and consumption which formerly were so often out of balance. Where pools of goods once were accumulated by the manufacturer, the wholesaler, the jobber, and the retailer; where high inventories once meant distress, shutdowns, failures, and unemployment whenever the demand subsided, there is now a more even flow from producer to consumer.

Yet the organic balance of our economic structure can be maintained only by hard, persistent, intelligent effort; by consideration and sympathy; by mutual confidence, and by a disposition in the several human parts to work in harmony together.

Letters to the Editor

Education of Engineers

Sir—The article by Sydney J. Williams in your issue of May 9, p. 744, on the education of the engineer, is decidedly interesting; especially the question he asks, "Why should not our engineering colleges impart the rudiments of the social as well as the physical sciences?"

It is not only the social "sciences" that the engineer should be taught or should acquire, but something of the social graces and amenities.

The engineer, especially the field engineer whose working career has started on a survey party or on a construction job, has to be more or less, and rather more than less, a pretty tough bird and glories in thinking himself a "rough-neck." With all that, and he has to be all that, he should be able to handle himself in a ball room, balance an egg-shell tea cup on one knee and a sandwich plate on another, and carry on a conversation with a pretty girl, if you please, a "society matron" at the same time.

He should be able to get up on his feet and make a polite little speech after dinner and not just be able to mumble over a professional paper before his brother engineers.

It won't hurt him to be affiliated with the government of the community in which he lives, if he ever lives there long enough.

Whether these things can be taught in the colleges, I don't know, but the really fundamental trouble with the results of the college training of engineers, as I have seen it, is that so many of the students get their minds so deeply imbedded in the groove of mere enginering technique that they are never able to flop over the sides and get any knowledge of what else is going on in the world. Not only are they shy of knowledge of business, finance, and economics, but of literature, art, historical perspective, and social usage, all of which have their uses even to a rough-neck engineer.

This is old stuff, but if it were possible to check up on the lives and careers of those engineers who have succeeded, it would be found that they have lots more than the technique of their profession. The chances are, however, that they had it in them anyway and didn't learn all of it in school, or their natural bent enabled them to get the right proportions out of the educational feast presented to them. It's the proper proportion of all things that counts.

F. Lavis,
Consulting Engineer.

New York, N. Y.,
May 13, 1929.

New Orleans Storm-Tide Hazard

Sir—Accompanying the article An Estimate of Storm-Tide Hazards to New Orleans by A. M. Shaw in *Engineering News-Record* of May 2, 1929, p. 698, are remarks by your editor entitled "A City is Warned." The following quotation from this warning has created quite a stir here and has, no doubt, reacted adversely to the city elsewhere:

"New Orleans lets the federal authorities spend millions to protect its water front by the Bonnet Carrè spillway, when a tropical storm of whose direction there is no definite assurance might drown its inhabitants like rats."

There naturally arises the question as to whether or not this conclusion is justified by the conditions.

I have given this question close study for many years in my fight for a spillway above New Orleans to afford not only protection to that city but also relief at the mouth of the Red River which would benefit the entire 15,000 sq.mi. comprising the flood plain of the state of Louisiana and to some extent the Yazoo basin in Mississippi.

Mr. Shaw's figures as to flood heights have been personally verified by me, as have also his calculations as to the capacities of the Rigolets and the Chef Menteur to bring the water of the gulf into Lake Pontchartrain. It must be remembered that the same capacity is there to return this same water to the gulf when the wind changes from south and east to west and north, which it necessarily must always do after a storm.

A few days after the storm of Sept. 29, 1915, probably the most violent storm that ever struck New Orleans, I picked a piece of an old shirt and some water hyacinths out of the branches of a tree, 13 ft. from the ground at the west end of Lake Pontchartrain, at the twenty-second mile post from New Orleans on the Illinois Central R.R. These had been put there by the water from the lake during the storm. The same day I measured the high water mark of the storm at Pass Manchac, near the thirtieth mile post and found it only 4½ feet above mean gulf level. At the Lake Pontchartrain end of Pass Manchac it was 6 ft. above mean gulf level.

Mr. Shaw shows that during that storm the lake at New Orleans was only 2 ft. above mean gulf level, but rose the next morning to 4 ft. after the storm was over and the wind had gone north, while at Frenier, opposite the twenty-second mile post where it had been 13 ft. the day before, it had dropped to 2 ft.

This brings us to the vital question whether or not your editor is right in his assumption that there is no definite assurance as to the direction of a tropical storm.

Being a life long resident on the Louisiana gulf coast, I have experienced many tropical storms. The first great one of my recollection was on Sept. 1, 1879. The rule is invariable that the winds begin in the east or northeast. The first effect is to blow the Atlantic Ocean into the gulf, raising it as much as 6 ft. above mean gulf level. I am not aware of any record in excess of 6 ft. on the open coast. Only by impounding the water and driving it ahead of the wind into a funnel can a greater height than this be attained.

With a head of 6 ft. in the gulf, Mr. Shaw estimates that a million sec.-ft. can enter Lake Pontchartrain through the Rigolets and the Chef Menteur. This estimate is not excessive but the water cannot attain a greater height than 6 ft. on the level.

New Orleans is on the southeast coast of Lake Pontchartrain and is a lee shore to any approaching tropical storm. For that reason during a storm, lake level at New Orleans is invariably less than on the opposite shore or up in the

cove to the west. Before New Orleans can become a windward shore, the wind must change to the west or northwest. When it changes, the gulf falls almost instantly to a foot or more below mean gulf level and the water races out of Lake Pontchartrain at a furious rate, even faster than it came in. Before it can lower the lake level to normal some water piles up on the New Orleans side but never as much as the opposite side experienced during the storm.

It is doubtful if the records could show during the more than 200 years since New Orleans was founded, that Lake Pontchartrain has ever risen as much as 6 ft. above normal at New Orleans. Over this height there should be an adequate margin of safety. A levee with a crown 10 ft. above mean gulf level would be 100 per cent safe.

It is my guess that Mr. Shaw's article was inspired by a knowledge of the fact that the back levee at New Orleans cannot safely protect against more than half of 10 ft. of water from Lake Pontchartrain. The grade of this levee is I think supposed to be about 7 ft. above mean gulf level but it has not been kept up to that height.

On Good Friday, in 1927, while the great flood was at its highest, New Orleans was visited by a record rain of 14 in. This rain came out of the northeast and Lake Pontchartrain rose nearly 4 ft. at New Orleans. Lightning put half of the city pumping plant out of commission and much of the low part of the city was flooded.

Suspecting that the great volume of water in the city was not all caused from rain, the next day I walked the entire back levee of the city from end to end. I found that during the storm, most of the levee had a freeboard of from 2 to 3½ ft. but in three places the water had run over the levee from the lake into the city. This means that while most of the levee was up to the fixed grade height or near it, some of it was more than 3 ft. below that height. Due to negligence New Orleans had been exposed to some damage from floods, but to a far greater damage from a flood of unnecessary, injurious publicity.

Before spending $25,000,000 on the Industrial Canal, which, although ten years old, has as yet only a potential value, or $27,000,000 on the lake shore development, which is proving to be amply justified, New Orleans should have spent a paltry $100,000 or so on her back-protection levee.

I cannot agree with Mr. Shaw that "lack of consciousness by the public that anything needs to be done" is the chief obstacle. It is a plain case of negligence by those in authority. The argument is unconvincing that it is easier to raise fifty odd million dollars for new development than it is to raise say one hundred thousand dollars for necessary protection. Geo. J. Earl, head of the Sewerage and Water Board has been crying out for years for better protection from the lake but he belongs to a different department of the city government.

Fix up the back levee a little and the storm danger from the gulf will be eliminated.

If it is decided not to do away with the New Basin Canal and Bayou St. John which bring the lake into the heart of the city, install simple gates (not locks) at their entrances which can be closed in case the lake gets too high. This will be no impediment to navigation because before it would be necessary to close the gates, all craft on the lake would have sought shelter. As soon as the lake quiets the gates will automatically open. The cost of such gates would be only a few thousand dollars.

There is some fear that the Bonnet Carré spillway will enhance the storm hazard. There is nothing to justify this. At normal tide, if the spillway ran continually at 275,000 sec.-ft. it could raise Lake Pontchartrain only 2 ft. This seems to be agreed upon by all engineers who have studied the question. If, while the spillway was running full force, a storm were to raise the gulf level, no water could enter Lake Pontchartrain until an elevation of 2 ft. was reached. At that stage the effect of spillway and storm tide would neutralize each other. Above 2 ft., water would enter the lake from the gulf but at a less rate than would be the case if the spillway were not running. In fact, the combined flow into the lake from the spillway and the gulf would be equal to what would flow from the gulf alone, if the spillway were not running. There would be a slight change of distribution of the water in the lake due to its entering from a new point, but there would be no material added volume from the spillway. Of course, instead of all the water being gulf water, some would be spillway water. But since it is proposed to control the spillway by gates which can be closed if found necessary, this discussion becomes an academic one, in fact mere conversation.

J. P. KEMPER,
Consulting Engineer.

New Orleans, La.
May 13, 1929.

Inaccuracies in the Flood-Tide Editorial

Sir—At a meeting of the Louisiana Engineering Society on May 13 the paper by A. M. Shaw published in *Engineering News-Record* May 2, 1929, p. 698, was discussed as well as your boxed editorial on p. 699.

There was unanimity of opinion to the effect that the members of the Louisiana Engineering Society are convinced that the conclusions expressed in the editorial are not warranted either by the data contained in the paper or by the actual facts. The members of the society are not in agreement with all the data as stated by Colonel Shaw.

No consideration has apparently been given either in the paper or in the editorial to the extensive works now in progress along the Lake Pontchartrain front, and certainly no mention is made thereof.

It was directed by the meeting that this communication should be addressed to you, requesting you to send the writer of the editorial to New Orleans where the Louisiana Engineering Society will be glad to co-operate with him in every possible manner in obtaining all available information and data bearing on this subject. This we are sure will demonstrate fully to him and through him to your valuable publications the inaccuracies of his conclusions and the unnecessary harm which must result to this community from their publication.

FREDERICK H. FOX,
President.

New Orleans, La.
May 14, 1929.

F. A. MUTH,
Secretary.
Louisiana Engineering Society.

Capacity of the Saluda Dam Spillway

Sir—Arthur R. Wellwood's article on the design of the 11,000,000-yd. earth dam for Saluda River power project in *Engineering News-Record*, April 25, 1929, p. 669, mentions a maximum flood of 100,000 sec.-ft. from 2,396 square miles for a 20 year period. I wish to raise the question of adequacy of the design of the spillway. Mr. Wellwood states that, "A large factor of safety was applied in its design, and its capacity, taken in combination with a 5-ft. rise in the reservoir above normal high water level, is capable of carrying away 2½ times the maximum flow which resulted from the Aug. 10, 1928 flood—the greatest flood known in 20 years." This was estimated to be 100,000 sec.-ft. The spillway, if I have properly interpreted the article, will have a capacity not exceding 60,000 sec.-ft. When the New England and the Alabama floods are considered this capacity does not seem sufficient.

The floods that occurred in New England in November, 1927, produced a run-off of 100 sec.-ft. per square mile over 1,000 square miles of drainage area (*Engineering News-Record*, Nov. 24, 1927) and the Alabama flood of March 14, 1929, was caused by a rainfall in excess of 12 in. on saturated soils over considerable area and a maximum rainfall of 27 in. in nine hours. (*Engineering News-Record*, March 28, 1929.)

One half of the earth dams that have failed since 1900 as recorded in *Engineering News-Record* have failed because of inadequate spillways and this, the largest of earth fill dams should be properly protected.

W. H. HOLMES.

Sacramento, Calif.,
May 9, 1929.

[Mr. Holmes appears to have overlooked the large storage capacity of the Saluda reservoir created by a 5-ft. rise in its surface area of 78 sq. miles. —EDITOR.]

News of the Week

South Bore Headings Meet in East River Twin Subway Tunnels

Shield Driving Through Sand and Clay on Fulton Street Line Sets New Speed Mark

THE south bore of the twin 18-ft. Fulton St. tunnels under the East River, New York, was holed through May 15, establishing a new speed mark for East River shield driving. A daily average of 17½ ft. per heading was maintained since the two shields started from bulkheads 2,979 ft. apart on January 6, 1929. Headings on the north tunnel will meet in a few days. This speed in shield driving through sand and clay has been surpassed only by the Hudson River tunnels, driven through silt.

The tunnels, a part of the city's new subway system, are being driven from shafts on the Brooklyn and Manhattan shores 3,226 ft. apart. In addition to the river section, land tunnels are being shield driven from the same shafts. These will be 2,621 ft. long on the Manhattan side and 2,744 ft. long on the Brooklyn side, making a total length of 8,591 ft. of tunnels. On the land sections O'Rourke's grouted gravel packing method is being used behind the shields to prevent settlement of the surrounding soil. This method eliminates the necessity of underpinning the adjacent building foundations. The shields each carry eighteen 10-in. hydraulic jacks using a pressure of 5,000 lb. per sq.in., or approximately 3,600 tons per shield. Before holing through on the south river section eight of these shields were in operation at once.

The subway is being built by the Board of Transportation of New York City, with Jesse B. Snow, engineer, Tunnel Division, and W. McK. Griffin, general resident engineer, in direct charge. Mason & Hanger, Inc., is the contractor with Miles I. Killmer general superintendent on the project.

A.E.C. Names Committee on Dams

The committee on legislation pertaining to the safety of dams of the American Engineering Council has been appointed by President Arthur W. Berresford. It consists of the following: Gardner S. Williams, Ann Arbor, Mich., chairman; L. F. Harza, Chicago, Ill.; Charles G. Hyde, Berkeley, Calif.; W. P. Creager, Watertown, N. Y.; W. S. Lee, Charlotte, N. C. The first task of the committee will be to assemble and analyze data on present regulation, following which it will make its recommendations.

Destroy Standing Section of St. Francis Dam

That portion of the St. Francis dam which was left standing when the dam gave way at midnight on March 12, 1928, has been destroyed. Under the direction of R. R. Robertson, assistant engineer of the construction division of the Los Angeles Department of Water and Power, two tunnels 50 ft. below the base of the dam were bored and in them were placed 5 tons of high explosive. An excavation had been made in the bed of the stream on the down-stream side of the dam, and the charges were set off in such a manner as to break up the great rock and topple the pieces into the hole prepared for them. This remaining portion of the dam was 160 ft. high, 90 ft. wide and 100 ft. thick at the base and contained approximately 45,000 tons of concrete. The cost of burying it was estimated at $15,000, according to Mr. Robertson.

Mississippi Floods Reach Threatening Levels

New high water levels have put the Mississippi levees in danger at several points and have broken through at one point on the St. Francis River. According to the latest reports of May 21, the old Reelfoot levee, 10 miles south of Hickman, Ky., was crumbling and engineers sought a way to let the water flow through it gradually and against a new dyke a quarter of a mile to the east. If this can be accomplished it is believed a crevasse can be averted in that stretch of the embankment, which protects a large acreage in Lake County, Tenn.

Mounds Landing levee, north of Greenville, Miss., which had been threatened for several days, continued to resist. A loop box was under construction there to strengthen the weakening section.

Quick work is reported to have removed danger of a break in the Farelly Lake levee, 30 miles southeast of Pine Bluff, Ark., where a "boil" occurred May 20. In Little River County, Arkansas, 2,500 acres were under water and 100 families had been routed from their homes by the Red River overflow.

The break on May 20 in the St. Francis River levee near Kennett, Mo., had spread floor waters over approximately 25,000 acres of land, about 80 per cent of which was in cultivation. Some 500 families were affected.

A secondary rise in the Ohio, Tennessee and upper Mississippi rivers, it is thought, will result in the Mississippi going a few tenths of a foot higher than engineers south of Memphis had anticipated.

Fire, Explosion and Poison Gas Kill 125 in Cleveland Clinic

Disaster Started by Ignition of X-Ray Films—Gas Spread by Explosions and Ventilating System

EXPLOSIVE GASES generated by burning X-ray films, spread throughout the Cleveland clinic building by its ventilating system, resulted in a disaster which has caused, to date, 125 deaths among the 234 persons in the building on May 15. Most of these were killed by gas, and it is expected that more deaths will occur among those who were exposed to its effects.

Investigations begun after the disaster by city and state authorities and by the hospital officials have not yet been completed. It is believed, however, that a leaky steam pipe passing through a film storage room in the basement was the cause of the trouble. It is tentatively stated that heat from the escaping steam caused the films to give off gases which were not only toxic, but also inflammable and, when mixed with air, explosive. As the heat increased it is probable that spontaneous combustion occurred, resulting in the explosion of part of the gas, driving the rest of it throughout the entire four-story building. An automatic fire-door at the entrance to the film storage room failed to close, due to interference of a pipe with the weight provided to close it. Immediately outside of the fire door the fan of the ventilating system was located. This sucked in the gas and distributed it quickly throughout the building.

Witnesses who escaped the tragedy testify that there were two explosions; the first in the basement, and the second more general. Fire started immediately and spread up the rear stairway. This, however, caused little loss of life, the greater part of the deaths being attributed to gas, shock and the panic which followed.

Autopsies performed upon the bodies of victims indicate that the gases present varied in different parts of the building. Nitrogen dioxide, nitrogen peroxide, carbon monoxide, and hydrocyanic acid gas predominated, with smaller amounts of various bromine and chlorine compounds probably present. All of these are toxic, being related to the poison gases used during the war. A number of survivors who were apparently unharmed have died suddenly since the tragedy.

Early estimates place the damage to the building at about $800,000. The structure itself needs only minor repairs, most of the damage being confined to the furniture and equipment.

New Jersey Sues Designers of Collapsed Bascule Bridge

Suit against the Strauss Engineering Corporation of Chicago was ordered instituted May 14 by the N. J. State Highway Commission for damages sustained through the collapse of the east leaf of the Lincoln Highway bridge over the Hackensack River between Jersey City and Kearny on Dec. 15, 1928. The litigation will be referred to the Attorney General for action. This motion was adopted by the board following the receipt of the report on the investigation made into the collapse by O. E. Hovey and D. B. Steinman of New York and Professor George E. Beggs of Princeton University, engineers engaged by the Highway Commission to determine the cause of the break. The Strauss firm designed the bascule lift span, part of which fell after it had been raised for a passing boat.

Representatives of the Strauss Engineering Corporation appeared before the highway commission Jan. 15 and denied responsibility for the collapse. They held that wooden plugs were found on the main trunnion bearings in the grooves through which lubricant must pass for the bearings and that there was evidence of carelessness on the part of the contractor who put the bridge in service.

Engineers named by the highway commission asserted that tests showed that the wooden plugs did not interfere with the flow of lubricant and pointed out that the blocks were found only in the main trunnion bearings and not in the counterweight trunnion bearings. They further declared that strain gage readings after the application of fresh lubricant in the counterweight trunnion bearings showed that after a few operations of the west leaf stresses in the counterweight tower returned to substantially the same range of magnitude.

Chicago Closes Two Defective School Buildings

Defective construction of school buildings, so serious that two schools built about 1925 have been summarily closed as unsafe, has been discovered in Chicago by engineers appointed by the Board of Education to inspect the structures. Of thirty other schools, eleven may be made safe if repair and reconstruction work is undertaken promptly, while the remainder are said to be structurally safe though needing repairs. These 32 buildings represent a total cost of some $17,000,000. Inadequate and misplaced steel in reinforced-concrete, as well as spalling of the concrete, are among the defects noted. The Board of Education, recently reorganized, has for some years been under fire on account of political influence and continual internal dissension. It is now short of funds, so that raising money for the necessary extensive repair work will be a problem. The recent investigations were made under the direction of L. E. Ritter, I. F. Stern and the Robert W. Hunt Company.

Reproduction Cost Must be Considered in Rail Valuation

Supreme Court Finds Valuation of O'Fallon Railway Not Made According to Law

REPRODUCTION cost must be considered when seeking to ascertain the value of railroad properties for recapture purposes, according to the United States Supreme Court's decision in a suit to annul an Interstate Commerce Commission order which directed the St. Louis & O'Fallon Railway Company to place in a reserve fund one-half of its excess income during the years 1920 to 1923, and to pay to the commission the remaining half with 6 per cent interest beginning four months after the termination of the years 1921 to 1924, inclusive. The decision of the District Court, Eastern Missouri, was reversed and a decree entered annulling the order.

The St. Louis & O'Fallon R.R. is a small and relatively insignificant road but importance attaches to the case because it is the first instance in which the Interstate Commerce Commission attempted to collect excess income under the provisions of the Transportation Act of 1920. It was made a test case and carried to the Supreme Court in order to get a ruling upon which to base the final valuation proceedings on all the railroads of the country.

Two points were in question, first, whether the St. Louis & O'Fallon Railway, a 9-mile coal-carrying road owned by the same interests as control the Manufacturers Railway, a short switching railroad in St. Louis having no direct connection with the O'Fallon, was operated together with the Manufacturers as one system and so entitled to be considered with the Manufacturers Railway in determining excess income; and, second, whether the commission in finding a value for the O'Fallon had followed the mandate of the Transportation Act. The District Court decided that the two railroads were not operated as a single system, and in this finding the Supreme Court agreed. But with the District Court finding that the commission acted properly in fixing the value of the O'Fallon Ry., the Supreme Court disagrees. On this latter point the court said: "When seeking to ascertain the value of railroad property for recapture purposes must it (the commission) give consideration to current or reproduction cost? The weight to be accorded thereto is not the matter before us. No doubt there are some, perhaps many, railroads, the ultimate value of which should be placed far below the sum necessary for reproduction. But Congress has directed that values shall be fixed upon a consideration of present cost, along with all other pertinent facts; and this mandate must be obeyed.

"It was deemed unnecessary by the court below to determine whether the commission obeyed the statutory mandate touching valuations, since the order permitted the O'Fallon to retain an income great enough to negative any suggestion of actual confiscation. With this we cannot agree. Whether the commission acted as directed by Congress was the fundamental question presented. If it did not, the action taken, being beyond the authority granted, was invalid. The only power to make any recapture order arose from the statutes.

"The judgment of the court below must be reversed. A decree will be entered here annulling the challenged order."

The Supreme Court was not unanimous in its decision. A dissenting decision was written by Associate Justice Stone and another by Justice Brandeis, in which Justice Holmes and Stone concurred.

War Department Approves Bridge at Great Falls

Approval has been given by the Assistant Secretary of War, Col. Patrick J. Hurley, to the application of the Great Falls Bridge Company to construct a crossing over the Potomac River at Great Falls, ten miles up stream from the Francis Scott Key Bridge at Washington, D. C. An act of Congress, approved March 4, 1929, authorized the Bridge Company to use and occupy such Government owned land located at or near Great Falls as would be necessary to construct the bridge and its approaches.

Technical Committees at Work on Standard Building Code

Committees are now meeting weekly in San Francisco and in Los Angeles to work on details of the proposed standard building code which is being evolved for California cities with funds provided by the California Development Association. It is expected that the code can be completed this year. Previous announcement of this work appeared in *Engineering News-Record*, April 26, 1928, p. 678. Since that time the Pacific Coast Building Officials' Conference has joined in the work on the same basis as the other organizations. Including the money to be used in co-operating with the conference, a total of $30,000 has been allotted for the work by the California Development Association.

The move was initiated by the fire and disaster insurance committee of the California Development Association and is part of a program to improve and standardize building construction in that state to the end that quality of structures will be bettered, costs decreased and insurance rates lowered.

In its present form the work is being done by eight technical committees, each one representing one or more organizations, four in the north and four in the south part of the state. The chairmen of these committees constitute an executive committee, which thus consists of eight members, four from the north and four from the south.

Representation is as follows: Northern: (1) San Francisco and Sacramento sections, American Society of Civil Engineers; (2) Northern California Chapter, American Institute of Architects; (3) Pacific Coast Building Officials' Conference, northern group; (4) General Contractors of San Francisco, Inc. Southern: (1) Los Angeles and San Diego chapters, American Society of Civil Engineers; (2) Southern California Chapter, Associated General Contractors of America; (3) Pacific Coast Building Officials' Conference, southern group; (4) Southern California Chapter, American Institute of Architects.

These committees are reviewing the building codes of the principal cities of the United States. Particular attention is being given to the uniform building code of the Pacific Building Officials' Conference and to the reports of the building code committee of the United States Department of Commerce. Translations have been made of the specification on reinforced concrete in the principal European countries, and the latest specifications of all construction materials are being intensively studied.

The various divisions that will constitute the standard code to be evolved have been assigned to the several technical committees and it is intended that as soon as all of the data have been digested, each subcommittee will submit recommendations to the executive committee on that portion of the code assigned to it. The actual preparation of the code will be done by the technical editors to whom has been assigned the task of expressing in exact language the recommendations of the various subcommittees after final review by the group as a whole.

Permit Sought for Large Earth Dam in Michigan

The Newaygo County, Mich., Board of Supervisors has been asked by the Consumers Power Company of Michigan for a permit to construct a dam and power plant on the Muskegon River at Oxbow, Mich. The dam will have a total length of about 3,500 ft. and will be of earth, with a heavy concrete core wall from base to crest, and either a concrete or welded steel facing for the up-river slope. Preliminary estimates provide for 1,154,000 cu.yd. of excavation, 50,000 cu.yd. of reinforced concrete, and 6,000,000 lb. of structural and reinforcing steel. A conduit pipe spillway will be installed, consisting of three steel pipes incased in reinforced concrete, each with an inside diameter of 14 ft. A generating capacity of about 40,000 hp. is planned, the power house to be located at the downstream toe of the embankment. It will be supplied with water through steel pipes from an intake tower upstream from the dam.

Present plans provide that work on the project shall be started by Stevens & Woods, Inc., this year, and that the plant shall be completed during 1931.

Henry W. Blake, Street Railway Authority, Dies

Henry W. Blake, senior editor of *Electric Railway Journal*, died May 20 at his home in Englewood, N. J., at the age of 64. Virtually his entire life had been spent in the service of that journal.

Mr. Blake was a pioneer in the field of technical and industrial journalism. He joined the editorial staff of *Street Railway Journal*, a publication originally devoted to horse car transportation, in 1891 and became its editor in 1894. Mr. Blake continued his editorial connection with that paper without interruption until his death. His development of the electrical side of the journal with the new art that had grown up, led to the change of name to the present form in 1908.

Born in New Haven on December 7, 1865, Mr. Blake graduated as a civil engineer from Yale University in 1886. He then studied electrical engineering in the Massachusetts Institute of Technology. Following this course, he was engaged in advertising work for the Sprague Electric Railway and Motor Company, an organization engaged in the construction of electric railways in various cities in the United States. He left the Sprague organization to join the staff of *Street Railway Journal*.

In 1927, Mr. Blake took an extended editorial tour abroad, studying and seeking special articles about street railway transportation systems in Europe. He visited Naples, Rome, Florence, Milan, Nice, Paris, Brussels, Berlin, Hamburg and London. He was active in the affairs of the American Electric Railway Association and was a regular attendant at its annual meetings. He was also a member of the American Institute of Electrical Engineers, the Engineers Club of New York and an associate member of the Union Internationale de Tramways et de Chemins de Fer d'Interet Local of Brussels.

Appreciation by James H. McGraw

James H. McGraw, founder and head of the publishing company, with whom Mr. Blake had been continuously associated during his thirty-eight years of service with the paper, said of him:

Henry W. Blake was a great editor. His name will go down in the history of industrial journalism with the names of other leaders who have passed away: Henry G. Prout of *Railway Gazette*, W. D. Weaver of *Electrical World*, Arthur M. Wellington of *Engineering News*, Charles Kirchhoff of *Iron Age*, John M. Goodell of *Engineering Record* and Frank Wight of *Engineering News-Record*. For thirty-eight years he was intimately associated with the upbuilding of the *Electric Railway Journal* and of the McGraw-Hill Publishing Company. Very early in his career he grasped the ideal of editorial service and leadership upon which this institution was founded, and succeeded to the editorship of his paper in 1894, three years after joining its staff.

In those days, the *Street Railway Journal* was devoted to the interests of the horse, its care and its car. But electric propulsion was being promoted by men who saw the limitations of the horse and cable, and the possibilities of electricity. Convinced with me of the fundamental principle of technical and business journalism, that industry is always ready for real leadership, Henry Blake took hold of the helm of his paper firmly. In recognizing that the editor's responsibility is not merely to present current news and opinion, but to provide a vehicle for advancing thought, he stamped the imprint of his mind and personality indelibly upon the paper and the industry to which his life was devoted.

Jadwin to Represent War Dept. at World Engineering Congress

The Secretary of War has officially designated Major Gen. Edgar Jadwin, Chief of Engineers, as the representative of the U. S. War Department at the World Engineering Congress to be held in Tokyo, Japan, this fall.

Chicago Sanitary District Has More Troubles

As a result of the investigation into the mismanagement of the affairs of the Sanitary District of Chicago, the grand jury has returned indictments against fifteen persons; six of the present members of the Board of Trustees, the ex-president (not now a member), T. J. Crowe, and eight employees, these last including the former chief clerk, purchasing agent and some politicians listed on the pay roll. The specific charge in the indictments is the defrauding of the District of the sum of $250,000, numerous items being cited of illegal expenditures for entertainments and political purposes. Following this, the state's attorney has applied to the court for permission to bring suit to oust the present board of trustees from office, on the ground of failure to comply with a state law requiring an annual report and financial statement to be field by Nov. 30. Such a report has been filed recently, but is said not to meet the requirements, besides being some months late. Furthermore, several of the trustees have been interrogated by a committee of the Illinois legislature appointed to investigate reports as to the District having a number of the legislators on its pay-roll.

Another line of trouble has developed in the failure of the city of Chicago and several of the smaller municipalities within the District to submit their sewerage plans to the District officials for approval or revision, as required by a state law passed in 1927. This law was intended to insure a comprehensive and economical system of sewers serving the entire area, but it applies only to sewers built by special assessment. It is claimed that the District did not notify the local authorities even when it was known that sewer work was planned, but on the other hand it is claimed that the local legal advisers

should have warned the authorities of the existence of this law. As a result of failure to comply with the law and to co-operate in general with the Sanitary District, additional cost and work will be involved in correcting unsatisfactory connections and in linking up certain sewers and suburban sewer systems with the sewerage system as planned by the District. This situation is said to threaten the validity of certain bond issues for work done without complying with the law, while several projects which have neared the construction stage may be held up by objections on the part of the District. An amendment by which the law would apply to all sewer work, however, financed, is now proposed, but this does not relieve the present trouble and confusion.

Gravity Colorado River Aqueduct Proposed to Water Board

A plan for an all-gravity aqueduct to bring water from the Colorado River to southern California was presented by E. C. La Rue, consulting engineer, at a meeting of the board of directors of the Metropolitan Water District held April 26. This water district is composed of a number of communities in southern California interested in obtaining a municipal water supply from the Colorado River. An outline of the organization was published in *Engineering News-Record*, March 28, 1929, p. 512.

Unlike all other projects, Mr. La Rue's scheme is for an all-gravity flow line and avoids the 1,600-ft. pumping lift that is an expensive feature of other routes. Features of the location he proposes are reported to include 167 miles of grade tunnel, 15 miles of pressure tunnel and 176 miles of covered aqueduct, the total aqueduct length being about 360 miles. For a 1,500-sec.-ft. capacity, he estimates the cost as $219,000,000, and the construction period as about eight years.

The water district board referred the report to its engineers for study.

Brief News

DEVELOPMENT of facilities in the port of Albany, N. Y., are authorized in a bill passed by the legislature and signed by Governor Roosevelt. By the new law the port commission has power to adopt a comprehensive plan, to acquire land and to issue bonds.

ELIMINATION of the the double grade crossing at Lindell Drive and Union Boulevard, St. Louis, by depressing the railroad tracks and constructing a $480,000 viaduct has been decided upon by representatives of the Wabash Railway and city officials.

IN FURTHER DEVELOPMENT of Seattle's Skagit hydroelectric project, the city council has authorized the board of public works to draft plans and specifications and award a contract for the construction of a 2,100 ft. tunnel from the Diablo dam, now under construction, to the site of the proposed Diablo power house on Reflector Bar, at an estimated cost of $1,000,000.

THE SOUTHERN PACIFIC RAILWAY on May 10 celebrated its sixtieth anniversary of the completion of its transcontinental line, the first in the United States.

COURSES offered during the summer by the Harvard School of Business Administration include: Interpretation of financial statements, public utility, management and economics, railway transportation, bank and trust management, sales management and retail distribution. The summer session lasts from July 1 to August 10.

THE SUPERIOR COURT of Lewis County, Wash., has handed down a decision that the special election held in Centralia, Wash., at which the city voted $1,000,000 for the construction of a municipal hydroelectric plant on the Nisqually River, is legal and valid. The case will probably be appealed to the State Supreme Court.

A.G.C. Meeting Considers Means of Improving Industry

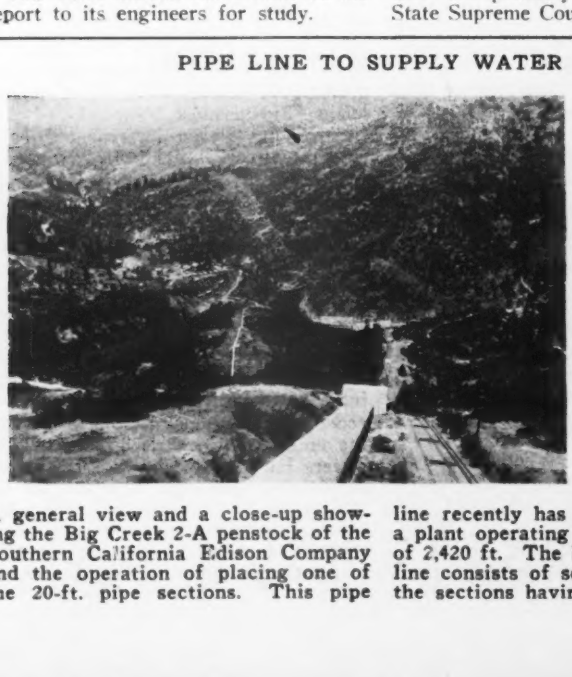
At the spring meeting of the Associated General Contractors held in Oklahoma City May 16-18 it was brought out that the activities of the organization tending to promote standardized credit practices in the building industry are among the most important undertakings on the program. In addition to approving the work that is being done in bringing about standard credit terms on building materials and construction equipment, and in establishing systems for prequalifying bidders, a resolution was adopted appointing a committee of three to determine the feasibility of bringing the entire construction industry into a trade practice conference with the Federal Trade Commission. This committee is headed by Ward P. Christie, staff engineer of the Associated General Contractors.

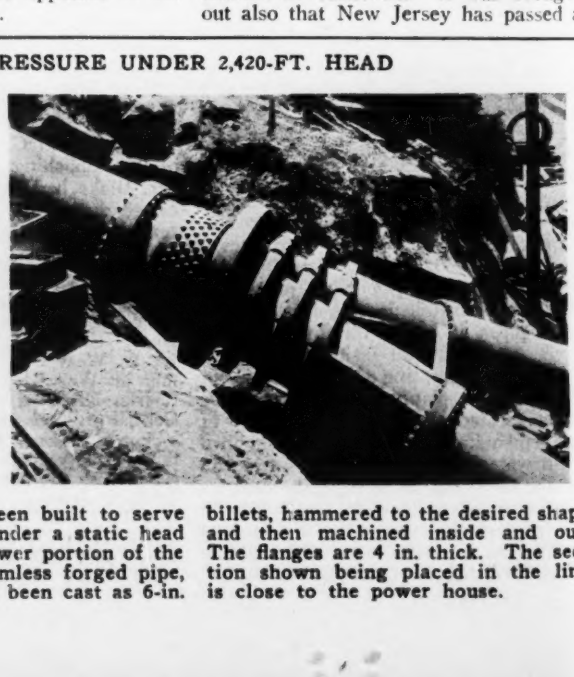
The particular purpose that can be served by a trade practice conference, it was explained, will be the formulation of agreements to prevent general contractors from shopping around in subletting contracts after they have secured a bid. If a fairly definite code can be agreed to in this connection, the Federal Trade Commission can be relied upon to enforce it.

After the reports from the various states on prequalification had been assembled, it was decided that enough information has been compiled on this subject to enable the general program to be carried out with all possible dispatch. In Oregon the prequalification bill received a large majority in both houses of the legislature, but was vetoed largely through a lack of understanding of the provisions of the measure.

The Seattle chapter reported that definite progress is being made toward the enactment of prequalification legislation, and it was brought out that a bill covering this subject has been approved by both branches of the legislature in California. It was brought out also that New Jersey has passed a

PIPE LINE TO SUPPLY WATER PRESSURE UNDER 2,420-FT. HEAD





A general view and a close-up showing the Big Creek 2-A penstock of the Southern California Edison Company and the operation of placing one of the 20-ft. pipe sections. This pipe line recently has been built to serve a plant operating under a static head of 2,420 ft. The lower portion of the line consists of seamless forged pipe, the sections having been cast as 6-in. billets, hammered to the desired shape and then machined inside and out. The flanges are 4 in. thick. The section shown being placed in the line is close to the power house.

prequalification law and that Pennsylvania has succeeded in getting legislation on the matter approved by its state congress, although one bill authorizing prequalification on municipal work was vetoed by the governor. The adverse action of the New York state committee was attributed to the fact that sufficient time was not allowed for proper presentation of the subject.

The proposal to establish an agreement of credit terms between bankers and contractors regarding the making of loans on equipment purchases received unanimous approval. Full agreement was reached also on the proposal to establish a national contract bureau in Washington for the purpose of listing public works contractors as to their experience and responsibility. The allied committees plan of establishing credit bureaus for the building and construction industries was reported to be under way in 30 cities. In Detroit, where the work has been in progress for the longest period, over $4,000,000 has been listed in past due accounts, it was stated. Good results also are being accomplished in Louisville, Cincinnati, Los Angeles and Memphis.

The activities of the contractors, directed toward the working out of standard sales terms for equipment, depend for their success on the manner in which the contractors can be induced to cooperate, it was held.

That the manufacturers can be relied upon to stop loose selling practices if the contractors present a solid front was the consensus of opinion. The most troublesome feature in this connection, it was agreed, is over the matter of turn-in values on old equipment.

Regarding the policy of the Associated General Contractors to favor voluntary effort over an elaborate safety code for cutting down the accident rate, the affiliated organizations gave their full approval. As a result of material presented, it was decided that, under actual working conditions, better results have been accomplished through educational work on the part of contractors themselves than could be expected through the imposition of a hard and fast regulating measure.

To Present Regional Plan for N. Y. Metropolitan District

At a meeting to be held May 27 the Committee on Regional Plan of New York and Its Environs make public a graphic plan for the future development of the territory within a distance approximately 50 miles from the New York City Hall, including parts of New York, New Jersey and Connecticut. The plan is the result of seven years of study by the committee and has been prepared at a cost of about $1,000,000, provided by the Russell Sage Foundation. The first part of the plan, to be presented May 27, is devoted principally to methods of communication and the apportionment of areas for residential, business and industrial uses. A second part, to be presented later, will deal with architectural and other ancillary features.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Mississippi Plans Still Meeting With Opposition—Power Project on Columbia River Recommended

IN ITS REPORT on engineering differences between the Jadwin and Mississippi River Commission flood control plans the board of review, appointed by former President Coolidge, defeated the intent of Congress. This was made possible by the selection of the Board's membership. The provision in the flood control act limiting the study to the two plans submitted "both of which were hastily prepared and based upon inadequate data," is unwise.

These opinions are expressed in a report submitted May 20 by the American Engineering Council to President Hoover. The report recommends "the creation by the Federal Government of a board of review composed of nonpartisan and competent engineers, with authority to develop the best possible solution of the Mississippi flood control problem." The new board of review, the report states further, "should, as soon as practicable, designate those features of construction which would be common to any acceptable plans, whereupon work should proceed upon them, and that pending such designation, work should be restricted to the repair, straightening and raising of existing structures and to the construction of the Bonnet Carre spillway."

The report was written by Engineering Council's flood control committee, which is made up of Gardner S. Williams, Baxter L. Brown, John F. Freeman and Arthur E. Morgan. It was approved by the executive committee of the council and was submitted to the president as the official statement of the organization. The committee calls attention in its statement to the report submitted to Congress in January, 1928, in which the point was made that "the data now available are altogether insufficient to warrant the laying out of a permanent plan of flood protection for the Mississippi Valley." At that time the creation of a Mississippi River Conservancy Board, of five or seven members, was recommended.

In a brief submitted to the President on the same day, a congressional committee composed of Senators and Representatives from the Mississippi Valley, contended that "it was the intent of Congress that the authority of the President to decide and direct should be continuous throughout the execution of the entire project on all phases and features of the problem within the jurisdiction of the Board." For that reason it is argued that the president has ample authority to reopen the entire study of the conflicting plans and may delay construction work on the portions of the project involved in the review. The point is made in the brief that Congress intended that payment be made for property rights. "If compensation is to be paid by the government for property," says the brief, "and the Jadwin plan is followed, its costs will exceed by many millions that of the Mississippi River Commission plan." The committee of legislators holds that the President should first determine "whether or not the government is to pay for property rights and, if so, then make a comparison of the engineering differences between the two plans. Our contention is that the law clearly provides for payment of these property rights by the government, hence it would be unwise to add enormously to the cost of the great project by adopting the Jadwin plan for floodways in the Atchafalaya and Boeuf basins, as this cost would exceed by many millions the aggregate cost of the Commission plan through those two basins. It seems to us that the report of the Board of Review having been acted upon by President Coolidge only in part, and rather indefinitely, should be reopened in its entirety and re-examined."

Rock Island Project Favored

A favorable report from the field has been received on the Rock Island project of the Washington Electric Company on the Columbia River. The granting of a preliminary permit for this large proposed development is recommended on condition that adequate provision be made for the passage of fish over the dam. Objections have been raised against all Columbia river projects by those who fear interference with the migration of salmon. In this case, however, a lower dam is involved at any of the other projects for which rights have been granted. It is believed that no great difficulties will be encountered in providing two satisfactory fish ladders over the Rock Island dam. In 1925 the Commission issued a license for the Priest Rapids project of the Washington Irrigation and Development Company which contemplates a much higher dam and a more difficult problem in safeguarding the interests of the fish industry.

Personal Notes

Jean L. Rilliet, Jr., has been appointed director of public utilities of St. Louis, Mo., filling the vacancy caused by the recent resignation of John C. Pritchard. Mr. Rilliet has been in the service of the city for thirteen years, starting as an engineer in the Water Department. He will have supervision of all utilities, including the water works, the municipal bridge, and electric and steam railroads.

Hugh L. Cooper, consulting engineer of New York City, has been elected a member of the Institution of Civil Engineers of England.

James Munn, construction engineer on the Mokelumne River water project of the East Bay Municipal Utility District, Oakland, Calif., resigned May 15 to become chief of construction for the water system of the Los Angeles De-

partment of Water and Power. Mr. Munn will have charge of the building of the reservoirs planned by the department, and it is also expected that he will direct construction of the Colorado River aqueduct.

W. A. WHITE, formerly of Portland, Ore., who has been connected with the engineering department of the Puget Sound Light and Power Company's southern division headquarters for two years, has been promoted to the position of general manager of the company's northwest division with headquarters at Port Angeles, Wash.

JOHN FLYNN, JR. formerly city engineer at Troy, N. Y., has been engaged by the Grade Crossing Commission to prepare plans for the elimination of grade crossings in that city.

DAVID B. RUSHMORE, consulting electrical engineer of New York City, has been appointed to represent the United States at the World Power Conference in Barcelona, Spain, this month. The subject of complete utilization of water power will be taken up at the meeting.

FRANK W. HANNA, since 1924 chief hydraulic and designing engineer for the East Bay Municipal Utility District, Oakland, Calif., has been named chief engineer and general manager for the district, succeeding Arthur P. Davis, resigned.

FRANK L. RASCHIG has been appointed chief engineer of the bureau of construction, Ohio Department of Highways. Mr. Raschig was lately chief engineer of the Cincinnati Rapid Transit Commission.

FRANK B. CAMPBELL, of Albany, N. Y., is now attached to the U. S. Geological Survey office at Denver, Colo., working on stream flow investigations.

EMIL A. NORDSTROM, structural engineer, has become associated with ELLIOTT B. HADLEY, architect, in the firm of Hadley and Nordstrom, with offices in St. Petersburg, Fla.

JOHN S. MACDONALD, chief engineer of Patrick McGovern, Inc., New York City, has been elected a vice-president and director of the corporation, succeeding Ellsworth D. Hubbard, resigned.

LT. FREDERICK A. HENNEY, Corps of Engineers, U. S. Army, has been authorized to attend the Swiss Federal Institute of Technology at Zurich, Switzerland, to which he was recently awarded a scholarship. Lt. Henney graduated from West Point in 1920, and is also a graduate of the Company Officers' Course, the Engineers' School, and is at present on duty as a student at the University of California.

GEORGE R. STELLER, Dayton, Ohio, for the past five years a designing engineer for the Ohio Department of Highways, has been made resident engineer in Montgomery and Butler counties, with headquarters in Dayton.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; annual meeting, Atlantic City, N. J., June 24-28.

AMERICAN WATER WORKS ASSOCIATION, New York: annual meeting, Toronto, Canada, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York: annual convention, Milwaukee, Wis., July 10-12.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

* * *

THE INTERNATIONAL CITY MANAGERS ASSOCIATION on June 1 will move its headquarters from Lawrence, Kan., to Chicago under an arrangement with the University of Chicago providing for co-operative studies and research. John G. Stutz is secretary of the association and Professor Leonard D. White is head of the university's Department of Public Administration.

THE DETROIT ENGINEERING SOCIETY has elected officers for 1929-1930 as follows: President, John P. Hallihan; vice-presidents, Edward M. Walker and Arthur S. Douglas; secretary and treasurer, Paul W. Thompson.

THE ENGINEERS CLUB OF HAMPTON ROADS held its last meeting of the season at Norfolk, Va., May 15. W. S. Rodman, dean of the department of engineering of the University of Virginia, spoke on "Modern Aspects of the Electrical Theory." Officers of the club are: President, W. T. Howe; vice-presidents, Harold C. Leonard and R. W. Kirkpatrick; secretary, T. G. Rydingsvard.

THE NEW ENGLAND WATER WORKS ASSOCIATION will hold its June outing at Swampscott, Mass., on June 18. The Boston Society of Civil Engineers has accepted an invitation to participate.

Obituary

WILLIAM AUSTIN BASSETT, director of the division of municipal and industrial research at Massachusetts Institute of Technology, died in Cambridge, Mass., May 16, at the age of 54. After graduating from the Lawrence Scientific School of Harvard University in 1901, he entered railway work for the Pennsylvania Railroad and the Boston Elevated Railway. From 1905 to 1907 he was a member of the engineering department of the city of Pittsburgh, and from then until 1910 on the faculty of Carnegie Institute of Technology. Later, Mr. Bassett entered the consulting field, specializing in engineering administration on government work. For ten years he was consulting engineer for the New York Bureau of Municipal Research. He was also dean of the division of engineering administration, National Institute of Public Administration; a member of the Hoover Committee for the Simplification of Building Codes and Practices, and a member of the advisory board for highway research of the National Research Council. Mr. Bassett was a member of the National Municipal League, the American Society of Civil Engineers, the American Society for Municipal Improvements, the American Association of Engineers, and the American Water Works Association.

HENRY MARCUS LANE, retired mechanical engineer, Cincinnati, Ohio, was killed in the Cleveland hospital accident on May 16. Mr. Lane was born at Cincinnati in 1854 and graduated from the Massachusetts Institute of Technology in 1873. He became associated with the Lane & Bodley Company, engine builders, of Cincinnati. Later he was construction engineer on the Elm St. and the Mount Adams inclined-plane cable railways in 1875 and 1879; the Gilbert Ave. and Vine St. cable railways in 1885 and 1887, and the cable railway at Denver, Colo., in 1888. Later he was connected with cable railways at Providence, St. Louis and St. Paul, and in 1890 became president of the Lane & Bodley Company. He was a member of the American Society of Mechanical Engineers and the Cincinnati Engineers Club.

A. W. MUNSTER, for the last five years consulting engineer for the city of Seattle on bridge construction, died in that city May 13 at the age of 75. Born in Norway, Mr. Munster came to the United States in 1881. Prior to opening offices as consulting engineer in Seattle in 1907, Mr. Munster had served as bridge engineer for the city of St. Paul, Minn., and as chief engineer of the Chicago Western Railroad.

PRESTON F. WRIGHT, 58 years old, principal draftsman in the United States Engineers office, Baltimore, died in a Baltimore hospital on May 10. He had been in the government service for seventeen years. In 1892 Mr. Wright became connected with the Mississippi River Commission and after six years with that body entered private business. He returned to the federal service in 1918.

JOHN B. ROGERS, 62, construction engineer, died in Beverly Hills, Calif., May 7. He was formerly with the government's geological survey work in the west, and was connected at other times with irrigation projects in Central Asia. In California he worked on the construction of the Ocean Shore Railroad from San Francisco to Santa Cruz.

CLYDE L. ISREAL, well known St. Louis County road and street contractor, died in that city May 7 from a nervous breakdown. He had been building roads and streets in the vicinity of St. Louis for about twenty years, and at the time of his death was engaged in three paving contracts aggregating over $100,000.

E. M. TERRY, professor of engineering physics at the University of Wisconsin, died May 1, at Madison, Wis.

Construction Equipment and Materials

Negotiating International Pact Among Iron Pipe Makers

Negotiations are in progress in London between representatives of the principal pipe-making manufacturers with a view to extending the scope and membership of the International Pipe Entente to include English, American, and Canadian producers, according to a statement of the U. S. Department of Commerce. The proposed agreement will apply to gas, water and steam pipe, and to seamless tubing and oil pipe as well. Under the plan, quotas will be established for each country, and an agreement set up prohibiting exportation of pipe by one member country into the domestic territory of another. Further details have not been made public.

Business Notes

ALEMITE MANUFACTURING CORPORATION, Chicago, announces the purchase of the line of industrial lubricating equipment bearing the Dot name formerly manufactured by the CARR FASTENER COMPANY, Cambridge, Mass. The latter company will concentrate on the manufacture and sale of its line of fasteners, while the Alemite Corporation will continue the manufacture and sale of the Dot lubricating equipment.

SULLIVAN COMPANY, Memphis, Tenn. and Montreal, Canada, manufacturers of a product known as Konset, which is claimed to waterproof, accelerate, harden and lubricate portland cement and can be furnished in all colors, has taken over the Paint Products Company, Cement Products Company, Bailey-Hehnen Company and the Geo. M. Tagg Paint Company, all of Memphis, Tenn.

CHICAGO PUMP COMPANY, Chicago, announces the addition of W. T. Morgan formerly of Gould's Pumps, Inc., to its organization. Mr. Gould will be assigned to the New York office where he will serve in the capacity of manager of engineering service.

UNIVERSAL POWER SHOVEL COMPANY, Detroit, has become a subsidiary of the Unit Corporation of America, with plants at West Allis, Wis., and Kalamazoo and Detroit, Mich.

AMERICAN CEMENT TILE MANUFACTURING COMPANY, Pittsburgh, Pa., has shipped equipment and personnel to Rio de Janeiro, Brazil, to manufacture approximately 500,000 sq.ft. of cement tile roofing to be used in the new shops of the Rio de Janeiro Tramway, Light & Power Company, Ltd. This unusual course was taken because the size and nature of the material makes it impracticable to resort to water shipment, as crating is necessary. The job will be under way about June 1, and will be completed within eight or ten months.

TRUSCON STEEL COMPANY, Youngstown, Ohio, has appointed Garrett Connors general purchasing agent for the company. Mr. Connors was formerly safety director, and also has held the posts of employment manager and general efficiency engineer for the Truscon industries.

READING IRON COMPANY, Reading, Pa., has established a new office at 402 Mutual Building, Kansas City, Mo., in charge of H. D. Pollard.

THE WEHR COMPANY, Milwaukee, Wis., is building a new plant at Cudahy, a suburb of Milwaukee. The building is of modern brick, saw-tooth construction, with outside dimensions approximately 450 x 360 ft.

PENNSYLVANIA PUMP AND COMPRESSOR COMPANY, Easton, Pa., has appointed Wells Fargo & Company, Express, S. A., as its agent for the Republic of Mexico.

New Developments

Power Shovel Improved In Speed and Power

The improved model B-3 one-half yard full revolving, convertible shovel of the Speeder Machinery Corporation, Cedar Rapids, Iowa, has a hoist line speed of 180 ft. per minute, a swing speed of more than 4 r.p.m. and a travel speed of 1.5 m.p.h. in high gear, and .55 m.p.h. in low gear. In low gear the machine will climb a 35 per cent grade, according to the manufacturer.

The company's patented direct cable crowd is used. The working principle is the same as in previous models, but is improved in view of the fact that two short cables are used rather than one long cable, thus in case of breakage necessitating the replacement of a short cable rather than a long one.

The speed of the crowding action also has been increased.

Among other improvements is a new steering mechanism that permits sharp or gradual turns under most adverse conditions; heavier construction throughout; electric lights and starter as standard equipment; a new style steel cab; six carrier trunnions for the upper body instead of four as in previous models; and a motor with 4¼x5½-in. bore that develops full 53 hp. As a shovel, the machine carries and 18-ft. boom and as a crane carries either a 30 or 35-ft. boom as the service demands.

A New Small Backfiller

Among the recent developments in construction equipment is the Model F backfiller built by the Buckeye Traction Ditcher Company, Findlay, Ohio. It is said to be a miniature of the company's larger models. Its features

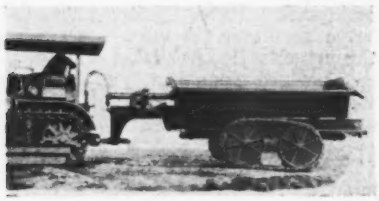
are as follows: It is powered with a 4-cylinder medium speed heavy duty engine with twin-disc clutch; the boom has a swinging range of 160 deg.; the brakes attached directly to the crawler traction wheels, provide for safe operation on steep grades and as each wheel is independently driven, the unit can turn completely around in its own length; the operating levers are arranged for one man control; the telescopically adjusted boom is controlled by hand wheels through worm and gear mechanisms from the operator's platform for both elevation and working angles.

Crawler Dump Wagon Utilizes Hydraulic Operated Doors

Two new models of crawler wagons with capacities of 6.2 and 7.3 cu.yd. (water level) have been announced by the LaPlant-Choate Mfg. Company, Inc., Cedar Rapids, Iowa. Numerous special features are incorporated in these new all steel wagons principal among which are the use of hydraulic lifting devices for raising the doors, a special spring type draw bar and flexible and easily operated crawlers.

The hydraulic system for operating the doors consists of a simple oil pump operated from the power take-off of the tractor and a heavy-duty large capacity low-pressure oil jack on the wagon. The tractor operator raises and dumps the doors from the driver's seat. A

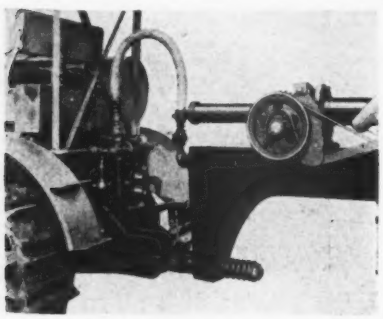
ratchet gear with trip dog holds the doors in position. Doors are dumped by means of a cable. Because of the



use of this hydraulic lifting device, the doors can be made unusually heavy and strong to withstand the hardest usage.

The wagon is of the cart type, having no wheels in front. Crawlers are manufactured under license of the Caterpillar Tractor Company of San Leandro, Calif., and utilize hardened and heat treated removable steel bushings and pins, one-spot greasing system, hardened and heat treated steel axles and a one-piece track link.

The loading height on the smaller



model with elevating grader flare boards is 61 in. while on the larger model with power shovel flare boards, it is 72 in. The doors when dumped leave a pile of dirt 4 ft. wide and 24½ in. high.

The special draw bar bolts onto the tractor and furnishes an extra strong link to withstand jerks from either direction and also to enable it to withstand the upward and downward pressures of overbalanced loads. Both models of wagons are 113 in. wide and 18 ft. 5 in. long overall.

New Publications

Metal Roofing — NEW JERSEY ZINC SALES COMPANY, 160 Front St., New York City, has issued a leaflet describing Zilloy roofing and siding for industrial buildings, and giving detailed directions for estimating quantities and methods of application.

Water Pipe—CAST IRON PIPE RESEARCH ASSOCIATION, 122 S. Michigan Ave., Chicago, has issued a booklet, illustrated, outlining the advantages of the two-main system of underground water piping.

Steel Roofs — R. C. MAHON COMPANY, Detroit, Mich., has issued a new catalog giving engineering data about the Mahon steel roof deck and including many drawings giving installation details. The new catalog fully describes a number of recent improvements.

Construction, Labor and Material

Building Permits Down in 1928

In 1928 the total value of building permits in 302 cities was $3,089,000,000, a decrease of 4.7 per cent from 1927, according to the Bureau of Labor Statistics figures just compiled. The value of permits for non-residential buildings was $1,181,000,000, which was 7.6 per cent less than for 1927. Permits for residential buildings were down 2.7 per cent.

Four classes of residential buildings, apartment houses, apartments with stores, hotels, and miscellaneous residential buildings, showed an increase over 1927, the decline being confined to one- and two-family dwellings with and without stores, and lodging houses.

Per capita expenditure for these permits amounted to $76.18, of which $68.96 was for new buildings, and $7.22 for repairs. The population of these 302 cities amounts to 44,940,000. The five leaders in per capita expenditure were White Plains, $440.15; Yonkers, $293.64; Evanston, $276.85; Mt. Vernon, New York, $260.74; and New Rochelle, $230.19. All these are suburban cities, four around New York and one near Chicago. Residential buildings account for the bulk of these per capita expenditures.

Ten Public Offerings Yield an Average of 4.89

Ten recent public bond offerings totaling $33,743,000 are listed in the accompanying table. Interest rates range from 4½ to 6, and average 4.825 per cent. Yields are from 4.05 to 5.80, and average 4.89.

	Amount	Interest Rate	Yield
Albany Co., N. Y.	$1,765,000	4½	5.00@4.05
Allegheny Co., Pa.	5,100,000	4½	4.25@4.10
Chicago, Ill.	8,933,000	4	4.90@4.25
Dallas Co., Tex., road	1,250,000	4½	6.00@4.50
Chicago Sanitary District	9,135,000	6	5.80
Hillside, N. J.	1,500,000	5½@6	5.00
Paterson, N. J.	2,184,000	4½	5.25@4.35
South Orange and Maplewood, N. J., school	967,000	4½	5.00@4.40
Winchester, Va.	349,000	4½	4.50
Province of Nova Scotia	2,560,000	5	5.00

High Output of Steel & Lumber; Cement ½ Per Cent Low

The accompanying table presents such production figures as are available for the first four months. Steel ingots are seen to be 13 per cent ahead of last year's output, and this high rate continues with mills operating at capacity. There is no indication of let-up in steel consumption and a lively demand is looked for as far ahead as the third quarter. Scattered price changes in the pig-iron list give evidence of the pressure from the steel market. Prices on the whole, however, are steady as indicated by the *Iron Age* composite pig-iron price of $18.71, compared with $18.46 a month ago and $17.42 a year ago, and a ten-year prewar average of $15.72. The finished steel composite price remains for the seventh week at 2.412c. per lb. compared with 2.348c. a year ago, and 1.689c. for the ten-year prewar average.

Cement production is ½ per cent under the figure for 1928. The April output was 13,639,000 bbl., with shipments of 13,319,000 bbl. The production rate for the month was 67.1 of capacity. This is an increase of 1.3 per cent over that of April, 1928. The shipment increase is 0.1 per cent.

Lumber production is seen from the table to be 36 per cent ahead of last year, with principal activity in timbers, and with housing lumber in much smaller demand. This situation is in keeping with construction volume this year, where heavy construction is high and smallsized construction is low.

Production, Jan. 1 to May 1:	1929	1928	
Steel ingots, tons	18,812,637	16,746,958	+13
Portland cement, barrels	42,011,000	42,256,000	— ½
Soft wood lumber, ft.b.m.	5,207,141,000	3,830,105,213	+36
Brick, common, orders on books Apr. 1, thousands	102,389,000	251,105,000	
Steel barrels	2,639,639	2,299,532	+15
Terra cotta, new orders, tons	44,236	49,923	—11
Railroad locomotives, shipments	142	222	—36

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of May 23, with some comparisons, total as follows:

(In Thousands of Dollars)

	May 23, 1929	May 16, 1929	May 24, 1928
Building:			
Industrial	$5,248	$10,895	$6,622
Commercial	68,288	73,111	26,196
Streets and roads	18,272	9,510	9,278
Other eng. constr.	16,943	46,091	19,227
Total	$108,751	$139,607	$61,323

Total, all classes, Jan. 1 to May 23:

1929	$1,856,839
1928	1,387,962

Contract value is 34 per cent above that of last year to date. Per cent gains are: industrial buildings, 32; other large buildings, 23; construction other than buildings, 29.

All construction, amounting to a billion and a half more than engineering construction, is within one per cent of last year's value. This evening up is due to a 27 per cent decline in small residential and other small projects.

E. N.-R. Index Numbers

Cost			Volume		
May 1,	1929	205.15	April,	1929	332
Apr. 1,	1929	203.40	March,	1929	382
May 1,	1928	207.00	April,	1928	316
Average,	1928	206.78	Average,	1928	287
Average,	1927	206.24	Average,	1927	263
1913		100.00	1913		100